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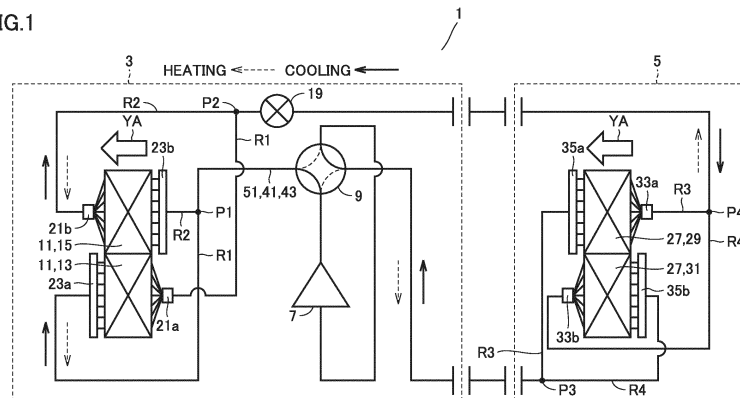
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(54) **AIR-CONDITIONER**

(57) An air-conditioner (1) is provided with a flow path (R1) including a portion through which a gas distributor (23a), a second part (13b), a first part (13a), and a gas-liquid two-phase distributor (21a) are sequentially connected. The air-conditioner is provided with a flow path (R2) including a portion through which a gas distributor (23b), a third part (15a), a fourth part (15b), and a gas-liquid two-phase distributor (21b) are sequentially connected. The flow path (R1) and the flow path (R2) are connected

in parallel with respect to a refrigeration cycle circuit (51) in such a manner that the gas-liquid two-phase distributor (21a) and the gas-liquid two-phase distributor (21b) are connected and the gas distributor (23a) and the gas distributor (23b) are connected. The first part (13a) is arranged on a windward side and the second part (13b) is arranged on a leeward side. The third part (15a) is arranged on the windward side and the fourth part (15b) is arranged on the leeward side.

FIG.1



Description

TECHNICAL FIELD

[0001] The present disclosure relates to an air-conditioner.

BACKGROUND ART

[0002] A non-azeotropic refrigerant mixture obtained by mixing at least two types of refrigerant is available as refrigerant to be used in a refrigeration cycle apparatus such as an air-conditioner. PTL 1 and PTL 2 disclose a refrigeration cycle apparatus where such a non-azeotropic refrigerant mixture is used.

[0003] In a heat exchanger in the refrigeration cycle apparatus where the non-azeotropic refrigerant mixture is used, in order to enhance efficiency of heat exchange between refrigerant and air, the heat exchanger is required to allow refrigerant to flow as a counterflow reverse in orientation to a direction of passage of air through the heat exchanger.

[0004] Therefore, various proposals have been made such that refrigerant flows through the heat exchanger as the counterflow in both of a case where the heat exchanger functions as a condenser and a case where the heat exchanger functions as an evaporator. Japanese Patent Laying-Open No. H08-170864 (PTL 1) proposes an air-conditioning apparatus including a six-way valve and an expansion valve. Japanese Patent Laying-Open No. H09-196489 (PTL 2) proposes an air-conditioner to which a bridge circuit including a check valve is applied.

CITATION LIST

PATENT LITERATURE

[0005]

PTL 1: Japanese Patent Laying-Open No. H08-170864

PTL 2: Japanese Patent Laying-Open No. H09-196489

SUMMARY OF INVENTION

TECHNICAL PROBLEM

[0006] In general, when a heat exchanger functions as an evaporator, in order to distribute refrigerant in a gas-liquid two-phase state containing gas refrigerant and liquid refrigerant that flows into the heat exchanger, a gas-liquid two-phase distributor is arranged on a refrigerant inlet side of the heat exchanger. In the gas-liquid two-phase distributor, in order to uniformly distribute refrigerant in the gas-liquid two-phase state, for example, an orifice is arranged.

[0007] When a heat exchanger functions as a con-

denser, on the other hand, in order to suppress pressure loss of gas refrigerant that flows into the heat exchanger, a gas distributor relatively large in volume is arranged on the refrigerant inlet side of the heat exchanger.

[0008] In a heat exchanger where general refrigerant is used, an orientation of a flow of refrigerant when the heat exchanger functions as the condenser is reverse to an orientation of a flow of refrigerant when the heat exchanger functions as the evaporator. Therefore, the gas-liquid two-phase distributor is arranged on one side of the heat exchanger and a gas distributor is arranged on the other side thereof.

[0009] In contrast, in the heat exchanger where the non-azeotropic refrigerant mixture is used, an orientation of a flow of refrigerant when the heat exchanger functions as the condenser is the same as an orientation of a flow of refrigerant when the heat exchanger functions as the evaporator.

[0010] Therefore, in an example where the heat exchanger functions as the condenser, for example, when gas refrigerant flows through the gas-liquid two-phase distributor where a distributor is arranged, the pressure loss is great. In an example where the heat exchanger functions as the evaporator, for example, when gas refrigerant that has exchanged heat flows through the gas-liquid two-phase distributor where a distributor is arranged, the pressure loss is great.

[0011] The present disclosure was made to solve such a technical problem, and an object thereof is to provide an air-conditioner where a non-azeotropic refrigerant mixture is used, the air-conditioner capable of achieving reduction in pressure loss.

SOLUTION TO PROBLEM

[0012] An air-conditioner according to the present disclosure includes a refrigeration cycle circuit provided with an outdoor unit and an indoor unit, a non-azeotropic refrigerant mixture circulating through the refrigeration cycle circuit. At least one of the outdoor unit and the indoor unit includes a first heat exchanger, a second heat exchanger, a first gas-liquid two-phase distributor, a first gas distributor, a second gas distributor, a second gas-liquid two-phase distributor, a first flow path, and a second flow path. The first heat exchanger includes a first part and a second part connected in series. The second heat exchanger includes a third part and a fourth part connected in series. The first gas-liquid two-phase distributor is connected on a side opposite to a side where the second part is connected, with respect to the first part. The first gas distributor is connected on a side opposite to a side where the first part is connected, with respect to the second part. The second gas distributor is connected on a side opposite to a side where the fourth part is connected, with respect to the third part. The second gas-liquid two-phase distributor is connected on a side opposite to a side where the third part is connected, with respect to the fourth part. The first flow path includes

a portion through which the first gas distributor, the second part, the first part, and the first gas-liquid two-phase distributor are sequentially connected. The second flow path includes a portion through which the second gas distributor, the third part, the fourth part, and the second gas-liquid two-phase distributor are sequentially connected. The first flow path where the first heat exchanger is arranged and the second flow path where the second heat exchanger is arranged are connected in parallel with respect to the refrigeration cycle circuit in such a manner that the first gas-liquid two-phase distributor and the second gas-liquid two-phase distributor are connected and the first gas distributor and the second gas distributor are connected. The air-conditioner has a first operation mode in which the first heat exchanger and the second heat exchanger function as a condenser and a second operation mode in which the first heat exchanger and the second heat exchanger function as an evaporator. With respect to a direction of passage of air that passes through the first heat exchanger and the second heat exchanger, the first part is arranged on a windward side, the second part is arranged on a leeward side, the third part is arranged on the windward side, and the fourth part is arranged on the leeward side.

ADVANTAGEOUS EFFECTS OF INVENTION

[0013] According to the air-conditioner according to the present disclosure, in the first operation mode, in the first flow path, a gaseous non-azeotropic refrigerant mixture flows into the first gas distributor and becomes liquid refrigerant in the first heat exchanger, and resultant liquid refrigerant flows through the first gas-liquid two-phase distributor, and in the second flow path, the gaseous non-azeotropic refrigerant mixture flows into the second gas distributor and becomes liquid refrigerant in the second heat exchanger, and resultant liquid refrigerant flows through the second gas-liquid two-phase distributor. In the second operation mode, in the first flow path, the non-azeotropic refrigerant mixture in the gas-liquid two-phase state flows into the first gas-liquid two-phase distributor and becomes gaseous refrigerant in the first heat exchanger, and resultant gaseous refrigerant flows through the first gas distributor, and in the second flow path, the non-azeotropic refrigerant mixture in the gas-liquid two-phase state flows into the second gas-liquid two-phase distributor and becomes gaseous refrigerant in the second heat exchanger, and resultant gaseous refrigerant flows through the first gas distributor. The pressure loss of the non-azeotropic refrigerant mixture that circulates through the refrigeration cycle circuit can thus be reduced.

BRIEF DESCRIPTION OF DRAWINGS

[0014]

Fig. 1 is a diagram showing a refrigeration cycle cir-

cuit of an air-conditioner according to a first embodiment.

Fig. 2 is a perspective view schematically showing a structure of an outdoor heat exchanger and the like in an outdoor unit in the embodiment.

Fig. 3 is a perspective view for illustrating a flow of refrigerant in the outdoor heat exchanger and the like during a cooling operation in the embodiment.

Fig. 4 is a perspective view for illustrating a flow of refrigerant in the outdoor heat exchanger and the like during a heating operation in the embodiment.

Fig. 5 is a diagram including a graph of a temperature of refrigerant and a graph of a temperature of air for illustrating a function and effect of the outdoor heat exchanger and the like during the cooling operation in the embodiment.

Fig. 6 is a diagram including a graph of a temperature of refrigerant and a graph of a temperature of air for illustrating a function and effect of the outdoor heat exchanger and the like during the heating operation in the embodiment.

Fig. 7 is a diagram showing the refrigeration cycle circuit of the air-conditioner according to a modification in the embodiment.

Fig. 8 is a diagram showing the refrigeration cycle circuit of the air-conditioner according to a second embodiment.

Fig. 9 is a perspective view schematically showing a structure of the outdoor heat exchanger and the like in the outdoor unit in the embodiment.

Fig. 10 is a perspective view for illustrating a flow of refrigerant in the outdoor heat exchanger and the like during the cooling operation in the embodiment.

Fig. 11 is a perspective view for illustrating a flow of refrigerant in the outdoor heat exchanger and the like during the heating operation in the embodiment.

Fig. 12 is a diagram including a graph of a temperature of refrigerant and a graph of a temperature of air for illustrating a function and effect of the outdoor heat exchanger and the like during the cooling operation in the embodiment.

Fig. 13 is a diagram including a graph of a temperature of refrigerant and a graph of a temperature of air for illustrating a function and effect of the outdoor heat exchanger and the like during the heating operation in the embodiment.

Fig. 14 is a diagram showing the refrigeration cycle circuit of the air-conditioner according to a third embodiment.

Fig. 15 is a perspective view schematically showing a structure of the outdoor heat exchanger and the like in the outdoor unit in the embodiment.

Fig. 16 is a perspective view for illustrating a flow of refrigerant in the outdoor heat exchanger and the like during the cooling operation in the embodiment.

Fig. 17 is a perspective view for illustrating a flow of refrigerant in the outdoor heat exchanger and the like during the heating operation in the embodiment.

Fig. 18 is a diagram including a graph of a temperature of refrigerant and a graph of a temperature of air for illustrating a function and effect of the outdoor heat exchanger and the like during the cooling operation in the embodiment.

Fig. 19 is a diagram including a graph of a temperature of refrigerant and a graph of a temperature of air for illustrating a function and effect of the outdoor heat exchanger and the like during the heating operation in the embodiment.

DESCRIPTION OF EMBODIMENTS

First Embodiment.

[0015] An exemplary air-conditioner according to a first embodiment will be described. As shown in Fig. 1, an air-conditioner 1 is provided with an outdoor unit 3 and an indoor unit 5. A compressor 7, a four-way valve 9, an outdoor heat exchanger 11, an expansion valve 19, and the like are accommodated in outdoor unit 3. An indoor heat exchanger 27 and the like are accommodated in indoor unit 5.

[0016] Compressor 7, four-way valve 9, outdoor heat exchanger 11, expansion valve 19, and indoor heat exchanger 27 are connected through a refrigerant pipe 41 to make up a refrigeration cycle circuit 51. Refrigerant circulates through refrigeration cycle circuit 51 (refrigerant pipe 41). In air-conditioner 1, a non-azeotropic refrigerant mixture 43 is used as refrigerant. Non-azeotropic refrigerant mixture 43 refers to a refrigerant mixture obtained by mixing a plurality of single components, in which a gas phase and a liquid phase thereof are different in component from each other.

[0017] Outdoor heat exchanger 11 and the like will be described in detail. As shown in Figs. 1 and 2, outdoor heat exchanger 11 includes an outdoor first heat exchanger 13 as a first heat exchanger and an outdoor second heat exchanger 15 as a second heat exchanger. Outdoor second heat exchanger 15 is arranged on outdoor first heat exchanger 13. Outdoor first heat exchanger 13 includes a first part 13a and a second part 13b. First part 13a and second part 13b are connected in series. First part 13a and second part 13b are arranged along a direction of passage of air (see an arrow YA). First part 13a is arranged on a windward side. Second part 13b is arranged on a leeward side.

[0018] A gas-liquid two-phase distributor 21a as a first gas-liquid two-phase distributor is connected on a side opposite to a side where second part 13b is connected, with respect to first part 13a. A gas distributor 23a as a first gas distributor is connected on a side opposite to a side where first part 13a is connected, with respect to second part 13b.

[0019] Outdoor second heat exchanger 15 includes a third part 15a and a fourth part 15b. Third part 15a and fourth part 15b are connected in series. Third part 15a and fourth part 15b are arranged along the direction of

passage of air (see arrow YA). Third part 15a is arranged on the windward side. Fourth part 15b is arranged on the leeward side.

[0020] A gas-liquid two-phase distributor 21b as a second gas-liquid two-phase distributor is connected on a side opposite to a side where third part 15a is connected, with respect to fourth part 15b. A gas distributor 23b as a second gas distributor is connected on a side opposite to a side where fourth part 15b is connected, with respect to third part 15a.

[0021] Air-conditioner 1 is provided with a flow path R1 as a first flow path including a portion through which gas distributor 23a, second part 13b, first part 13a, and gas-liquid two-phase distributor 21a are sequentially connected. A flow path R2 as a second flow path including a portion through which gas distributor 23b, third part 15a, fourth part 15b, and gas-liquid two-phase distributor 21b are sequentially connected is provided.

[0022] Flow path R1 where outdoor first heat exchanger 13 is arranged and flow path R2 where outdoor second heat exchanger 15 is arranged are connected in parallel with respect to refrigeration cycle circuit 51 in such a manner that gas-liquid two-phase distributor 21a and gas-liquid two-phase distributor 21b are connected and gas distributor 23a and gas distributor 23b are connected. In other words, flow path R1 and flow path R2 are connected in parallel with respect to refrigeration cycle circuit 51 (main flow path) through which the non-azeotropic refrigerant mixture circulates.

[0023] Indoor heat exchanger 27 and the like will now be described. As shown in Fig. 1, indoor heat exchanger 27 includes an indoor first heat exchanger 29 and an indoor second heat exchanger 31.

[0024] A gas-liquid two-phase distributor 33a is connected on one end side of indoor first heat exchanger 29. A gas distributor 35a is connected on the other end side of indoor first heat exchanger 29. A gas-liquid two-phase distributor 33b is connected on one end side of indoor second heat exchanger 31. A gas distributor 35b is connected on the other end side of indoor second heat exchanger 31.

[0025] Air-conditioner 1 is provided with a flow path R3 including a portion through which gas distributor 35a, gas-liquid two-phase distributor 33a, and indoor first heat exchanger 29 are sequentially connected. A flow path R4 including a portion through which gas distributor 35b, indoor second heat exchanger 31, and gas-liquid two-phase distributor 33b are sequentially connected is provided.

[0026] Flow path R3 where indoor first heat exchanger 29 is arranged and indoor second heat exchanger 31 where indoor second heat exchanger 31 is arranged are connected in parallel with respect to refrigeration cycle circuit 51 in such a manner that gas-liquid two-phase distributor 33a and gas-liquid two-phase distributor 33b are connected and gas distributor 35a and gas distributor 35b are connected. In other words, flow path R3 and flow path R4 are connected in parallel with respect to refrigeration cycle circuit 51.

eration cycle circuit 51 (main flow path) through which a non-azeotropic refrigerant mixture circulates. Air-conditioner 1 according to the first embodiment is composed as above.

[0027] An operation (a flow of refrigerant) of air-conditioner 1 (refrigeration cycle circuit 51) described above will now be described.

(Cooling Operation)

[0028] A cooling operation as a first operation mode will initially be described as an operation of air-conditioner 1 (refrigeration cycle circuit 51). In this case, outdoor heat exchanger 11 in outdoor unit 3 functions as a condenser and indoor heat exchanger 27 in indoor unit 5 functions as an evaporator.

[0029] As compressor 7 is driven, high-temperature and high-pressure gas refrigerant (single phase) is discharged from compressor 7. Discharged high-temperature and high-pressure gas refrigerant is sent through four-way valve 9 to outdoor unit 3. In outdoor unit 3, sent refrigerant flows through outdoor heat exchanger 11. At this time, refrigerant flows through outdoor first heat exchanger 13 (flow path R1) and outdoor second heat exchanger 15 (flow path R2) in parallel. The flow of refrigerant in outdoor heat exchanger 11 will be described in detail later.

[0030] In outdoor heat exchanger 11, heat is exchanged between refrigerant that flows in and air supplied by a propeller fan (not shown). High-temperature and high-pressure gas refrigerant becomes high-pressure liquid refrigerant (single phase) by being condensed as a result of heat exchange.

[0031] High-pressure liquid refrigerant that flows through outdoor heat exchanger 11 and is sent out of outdoor unit 3 is converted by expansion valve 19 into refrigerant in the gas-liquid two-phase state containing low-pressure gas refrigerant and liquid refrigerant. Refrigerant in the gas-liquid two-phase state is sent to indoor unit 5. In indoor unit 5, sent refrigerant flows through indoor heat exchanger 27. At this time, refrigerant flows through indoor first heat exchanger 29 (flow path R3) and indoor second heat exchanger 31 (flow path R4) in parallel.

[0032] In indoor heat exchanger 27, heat is exchanged between refrigerant in the gas-liquid two-phase state that flows in and air sent into indoor heat exchanger 27 by a fan (not shown). Refrigerant in the gas-liquid two-phase state becomes low-pressure gas refrigerant (single phase) as a result of evaporation of liquid refrigerant by heat exchange. Air that has exchanged heat is sent from indoor heat exchanger 27 into an indoor space so that the indoor space is cooled.

[0033] Low-pressure gas refrigerant that flows through indoor heat exchanger 27 and is sent out of indoor unit 5 flows through four-way valve 9 into compressor 7. Low-pressure gas refrigerant that flows into compressor 7 becomes high-temperature and high-pressure gas refrigerant

ant by being compressed and is discharged again from compressor 7. This cycle is repeated hereafter.

(Heating Operation)

[0034] A heating operation as a second operation mode will be described as an operation of air-conditioner 1 (refrigeration cycle circuit 51). In this case, indoor heat exchanger 27 in indoor unit 5 functions as the condenser and outdoor heat exchanger 11 in outdoor unit 3 functions as the evaporator.

[0035] As compressor 7 is driven, high-temperature and high-pressure gas refrigerant (single phase) is discharged from compressor 7. Discharged high-temperature and high-pressure gas refrigerant (single phase) is sent through four-way valve 9 to indoor unit 5. Refrigerant sent to indoor unit 5 flows through indoor heat exchanger 27. At this time, refrigerant flows through indoor first heat exchanger 29 (flow path R3) and indoor second heat exchanger 31 (flow path R4) in parallel.

[0036] In indoor heat exchanger 27, heat is exchanged between gas refrigerant that flows in and air sent by the fan (not shown). High-temperature and high-pressure gas refrigerant becomes high-pressure liquid refrigerant (single phase) by being condensed. Air that has exchanged heat is sent from indoor heat exchanger 27 into the indoor space so that the indoor space is heated. High-pressure liquid refrigerant that flows through indoor heat exchanger 27 and is sent out of indoor unit 5 is sent to the outdoor unit.

[0037] High-pressure liquid refrigerant sent to outdoor unit 3 is converted by expansion valve 19 into refrigerant in the gas-liquid two-phase state containing low-pressure gas refrigerant and liquid refrigerant. Refrigerant in the gas-liquid two-phase state flows through outdoor heat exchanger 11. At this time, refrigerant flows through outdoor first heat exchanger 13 (flow path R1) and outdoor second heat exchanger 15 (flow path R2) in parallel.

[0038] In outdoor heat exchanger 11, heat is exchanged between refrigerant in the gas-liquid two-phase state that flows in and air supplied by the propeller fan (not shown). Liquid refrigerant in refrigerant in the gas-liquid two-phase state evaporates, and refrigerant in the gas-liquid two-phase state becomes low-pressure gas refrigerant (single phase).

[0039] Low-pressure gas refrigerant that flows through outdoor heat exchanger 11 and is sent out of outdoor unit 3 flows through four-way valve 9 into compressor 7. Low-pressure gas refrigerant that flows into compressor 7 becomes high-temperature and high-pressure gas refrigerant by being compressed and is again discharged from compressor 7. This cycle is repeated hereafter.

(Defrosting Operation)

[0040] Since outdoor heat exchanger 11 functions as the evaporator in the heating operation, frost may grow in outdoor heat exchanger 11. Therefore, in air-conditioner 1, a defrosting operation is performed.

tioner 1, a defrosting operation to remove frost that grows in outdoor heat exchanger 11 is performed. In the defrosting operation, by sending high-temperature and high-pressure refrigerant discharged from compressor 7 to outdoor heat exchanger 11 by performing an operation the same as the cooling operation, frost that grows in outdoor heat exchanger 11 is removed.

[0041] A general flow of refrigerant in air-conditioner 1 (refrigeration cycle circuit 51) is as described above. A flow of refrigerant in outdoor heat exchanger 11 and indoor heat exchanger 27 will now more specifically be described.

(Flow of Refrigerant in Outdoor Heat Exchanger 11 During Cooling Operation)

[0042] As shown in Figs. 1 and 3, high-temperature and high-pressure gas refrigerant (single phase) discharged from compressor 7 is sent through four-way valve 9 to outdoor unit 3. In outdoor unit 3, refrigerant is branched at a branch and merge point P1 into refrigerant that flows through flow path R1 and refrigerant that flows through flow path R2.

[0043] In flow path R1, high-temperature and high-pressure gas refrigerant successively flows through gas distributor 23a, second part 13b, first part 13a, and gas-liquid two-phase distributor 21a. In flow path R1, high-temperature and high-pressure gas refrigerant flows into gas distributor 23a and is condensed in outdoor first heat exchanger 13 to become high-pressure liquid refrigerant, and resultant high-pressure liquid refrigerant flows through gas-liquid two-phase distributor 21a. In outdoor first heat exchanger 13, refrigerant flows through second part 13b arranged on the leeward side and thereafter flows as a counterflow that flows through first part 13a arranged on the windward side.

[0044] In flow path R2, high-temperature and high-pressure gas refrigerant successively flows through gas distributor 23b, third part 15a, fourth part 15b, and gas-liquid two-phase distributor 21b. In flow path R2, high-temperature and high-pressure gas refrigerant flows into gas distributor 23b and is condensed in outdoor second heat exchanger 15 to become high-pressure liquid refrigerant, and resultant high-pressure liquid refrigerant flows through gas-liquid two-phase distributor 21b. In outdoor second heat exchanger 15, refrigerant flows through third part 15a arranged on the windward side and thereafter flows as a parallel flow that flows through fourth part 15b arranged on the leeward side.

[0045] High-pressure liquid refrigerant that flows through gas-liquid two-phase distributor 21a and high-pressure liquid refrigerant that flows through gas-liquid two-phase distributor 21b merge at a branch and merge point P2, and after merged refrigerant passes through expansion valve 19, it becomes refrigerant in the gas-liquid two-phase state containing low-pressure gas refrigerant and liquid refrigerant. Low-pressure refrigerant in the gas-liquid two-phase state is sent to indoor unit 5

(see Fig. 1).

(Flow of Refrigerant in Indoor Heat Exchanger 27 During Cooling Operation)

[0046] A flow of refrigerant in indoor unit 5 will now briefly be described in accordance with outdoor unit 3. As shown in Fig. 1, refrigerant that flows into indoor unit 5 is branched at a branch and merge point P4 into refrigerant that flows through flow path R3 and refrigerant that flows through flow path R4.

[0047] In flow path R3, refrigerant in the gas-liquid two-phase state successively flows through gas-liquid two-phase distributor 33a, indoor first heat exchanger 29, and gas distributor 35a. In flow path R3, low-pressure refrigerant in the gas-liquid two-phase state flows through gas-liquid two-phase distributor 33a and is evaporated in indoor first heat exchanger 29 to become low-pressure gas refrigerant, and resultant low-pressure gas refrigerant flows through gas distributor 35a. In indoor first heat exchanger 29, refrigerant flows as the parallel flow.

[0048] In flow path R4, refrigerant in the gas-liquid two-phase state successively flows through gas-liquid two-phase distributor 33b, indoor second heat exchanger 31, and gas distributor 35b. In flow path R4, refrigerant in the gas-liquid two-phase state flows through gas-liquid two-phase distributor 33b and is evaporated in indoor second heat exchanger 31 to become low-pressure gas refrigerant, and resultant low-pressure gas refrigerant flows through gas distributor 35b. In indoor second heat exchanger 31, refrigerant flows as the counterflow.

(Flow of Refrigerant in Indoor Heat Exchanger 27 During Heating Operation)

[0049] As shown in Fig. 1, high-temperature and high-pressure gas refrigerant (single phase) discharged from compressor 7 is sent through four-way valve 9 to indoor unit 5. In indoor unit 5, refrigerant is branched at a branch and merge point P3 into refrigerant that flows through flow path R3 and refrigerant that flows through flow path R4.

[0050] In flow path R3, gas refrigerant successively flows through gas distributor 35a, indoor first heat exchanger 29, and gas-liquid two-phase distributor 33a. In flow path R3, high-temperature and high-pressure gas refrigerant flows into gas distributor 35a and is condensed in indoor first heat exchanger 29 to become high-pressure liquid refrigerant, and resultant high-pressure liquid refrigerant flows through gas-liquid two-phase distributor 33a. In indoor first heat exchanger 29, refrigerant flows as the counterflow.

[0051] In flow path R4, gas refrigerant successively flows through gas distributor 35b, indoor second heat exchanger 31, and gas-liquid two-phase distributor 33b. In flow path R4, high-temperature and high-pressure gas refrigerant flows into gas distributor 35b and is condensed in indoor second heat exchanger 31 to become

high-pressure liquid refrigerant, and resultant high-pressure liquid refrigerant flows through gas-liquid two-phase distributor 33b. In indoor second heat exchanger 31, refrigerant flows as the parallel flow.

[0052] High-pressure liquid refrigerant that flows through gas-liquid two-phase distributor 33a and high-pressure liquid refrigerant that flows through gas-liquid two-phase distributor 33b merge at branch and merge point P4, and merged refrigerant is sent to outdoor unit 3.

(Flow of Refrigerant in Outdoor Heat Exchanger 11 During Heating Operation)

[0053] A flow of refrigerant in outdoor unit 3 will now be described. As shown in Fig. 4, high-pressure liquid refrigerant sent to outdoor unit 3 passes through expansion valve 19 and becomes refrigerant in the gas-liquid two-phase state containing low-pressure gas refrigerant and liquid refrigerant. Refrigerant in the gas-liquid two-phase state is branched at branch and merge point P2 into refrigerant that flows through flow path R1 and refrigerant that flows through flow path R2.

[0054] In flow path R1, refrigerant in the gas-liquid two-phase state successively flows through gas-liquid two-phase distributor 21a, first part 13a, second part 13b, and gas distributor 23a. In flow path R1, low-pressure refrigerant in the gas-liquid two-phase state flows through gas-liquid two-phase distributor 21a and is evaporated in first part 13a and second part 13b to become low-pressure gas refrigerant, and resultant low-pressure gas refrigerant flows through gas distributor 23a. In outdoor first heat exchanger 13 (first part 13a and second part 13b), refrigerant flows as the parallel flow.

[0055] In flow path R2, refrigerant in the gas-liquid two-phase state successively flows through gas-liquid two-phase distributor 21b, third part 15a, fourth part 15b, and gas distributor 23b. In flow path R2, low-pressure refrigerant in the gas-liquid two-phase state flows through gas-liquid two-phase distributor 21b and is evaporated in fourth part 15b and third part 15a to become low-pressure gas refrigerant, and resultant low-pressure gas refrigerant flows through gas distributor 23b. In outdoor second heat exchanger 15 (fourth part 15b and third part 15a), refrigerant flows as the counterflow.

[0056] In air-conditioner 1 where the non-azeotropic refrigerant mixture circulates described above, in each of the cooling operation and the heating operation, refrigerant in the gas-liquid two-phase state flows through gas-liquid two-phase distributors 21a, 21b, 33a, and 33b, and thereafter flows through corresponding outdoor heat exchanger 11 or indoor heat exchanger 27 to become gas refrigerant. Refrigerant that has become gas refrigerant in corresponding outdoor heat exchanger 11 or indoor heat exchanger 27 flows through gas distributors 23a, 23b, 35a, and 35b. Pressure loss or the like can thus be reduced, description of which will be given.

[0057] Initially, in general, when a heat exchanger functions as the evaporator, in order to uniformly distrib-

ute refrigerant in the gas-liquid two-phase state containing gas refrigerant and liquid refrigerant that flows into the heat exchanger, a gas-liquid two-phase distributor is arranged on the refrigerant inlet side of the heat exchanger. In the gas-liquid two-phase distributor, in order to uniformly refrigerant in the gas-liquid two-phase state, for example, an orifice is arranged.

[0058] When a heat exchanger functions as the condenser, on the other hand, in order to suppress pressure loss of gas refrigerant that flows into the heat exchanger, a gas distributor (gas header) relatively large in volume is arranged on the refrigerant inlet side of the heat exchanger.

[0059] In a heat exchanger in an air-conditioner where general refrigerant other than the non-azeotropic refrigerant mixture is used, an orientation of a flow of refrigerant that flows through the heat exchanger to function as the condenser is reverse to an orientation of a flow of refrigerant that flows through the heat exchanger to function as the evaporator. Therefore, the gas-liquid two-phase distributor is arranged on one side of the heat exchanger and the gas distributor is arranged on the other side thereof.

[0060] In contrast, in a heat exchanger according to a comparative example (PTL 1 and PTL 2) where the non-azeotropic refrigerant mixture is used, an orientation of a flow of refrigerant when the heat exchanger functions as the condenser is the same as an orientation of a flow of refrigerant when the heat exchanger functions as the evaporator.

[0061] A heat exchanger where a gas-liquid two-phase distributor is arranged on one side thereof and a gas distributor is arranged on the other side thereof is assumed.

[0062] When the heat exchanger functions as the evaporator, refrigerant in the gas-liquid two-phase state flows through the gas-liquid two-phase distributor and thereafter exchanges heat in the heat exchanger to become gas refrigerant, and resultant gas refrigerant flows through the gas distributor. When the heat exchanger functions as the condenser, on the other hand, gas refrigerant flows through the gas-liquid two-phase distributor and thereafter exchanges heat in the heat exchanger to become liquid refrigerant, and resultant liquid refrigerant flows through the gas distributor (first case).

[0063] Therefore, in particular when the heat exchanger functions as the condenser, gas refrigerant flows through the gas-liquid two-phase distributor to uniformly distribute refrigerant in the gas-liquid two-phase state, and hence pressure loss of refrigerant increases. Since liquid refrigerant flows through the gas header relatively large in volume, an amount of refrigerant increases.

[0064] A heat exchanger where the gas header is arranged on one side thereof and the gas-liquid two-phase distributor is arranged on the other side thereof is now assumed.

[0065] When the heat exchanger functions as the condenser, gas refrigerant flows through the gas distributor and thereafter exchanges heat in the heat exchanger to

become liquid refrigerant, and resultant liquid refrigerant flows through the gas-liquid two-phase distributor. When the heat exchanger functions as the evaporator, on the other hand, refrigerant in the gas-liquid two-phase state flows through the gas distributor and thereafter exchanges heat in the heat exchanger to become gas refrigerant, and resultant gas refrigerant flows through the gas-liquid two-phase distributor (second case).

[0066] Therefore, in particular when the heat exchanger functions as the evaporator, refrigerant in the gas-liquid two-phase state flows through the gas header relatively large in volume. Accordingly, refrigerant cannot uniformly be distributed and performance as the evaporator lowers. Since gas refrigerant flows through the gas-liquid two-phase distributor to uniformly distribute refrigerant in the gas-liquid two-phase state, pressure loss of refrigerant increases.

[0067] In the air-conditioner according to the comparative example, the orientation of the flow of refrigerant through a refrigerant pipe that connects the indoor unit and the outdoor unit to each other during the cooling operation is the same as that during the heating operation. During the cooling operation, in order to send to the outdoor unit, gas refrigerant that has flowed through the indoor unit, a refrigerant pipe relatively large in diameter should inevitably be used as the refrigerant pipe for suppression of pressure loss. During the heating operation, on the other hand, liquid refrigerant that has flowed through the indoor unit flows through this refrigerant pipe relatively large in diameter. Therefore, liquid refrigerant tends to remain in the refrigerant pipe and the amount of refrigerant increases.

[0068] The heat exchanger in air-conditioner 1 described above achieves an effect as follows, as compared with the air-conditioner according to the comparative example.

[0069] Initially, the effect in the case of the cooling operation as the first operation mode will be described. In this case, in outdoor unit 3 (outdoor heat exchanger 11), gas refrigerant flows through gas distributors 23a and 23b to appropriately distribute gas, and thereafter it exchanges heat in corresponding outdoor first heat exchanger 13 or outdoor second heat exchanger 15 to become liquid refrigerant, and resultant liquid refrigerant flows through gas-liquid two-phase distributors 21a and 21b.

[0070] Then, in indoor unit 5 (indoor heat exchanger 27), refrigerant in the gas-liquid two-phase state flows through gas-liquid two-phase distributors 33a and 33b where a distributor to uniformly distribute refrigerant in the gas-liquid two-phase state is arranged, and thereafter it exchanges heat in corresponding indoor first heat exchanger 29 or indoor second heat exchanger 31 to become gas refrigerant, and resultant gas refrigerant flows through gas distributors 35a and 35b.

[0071] Thus, gas refrigerant does not flow through the gas-liquid two-phase distributor as in the first case in the comparative example, and pressure loss of refrigerant

can be reduced. Furthermore, liquid refrigerant does not flow through the gas distributor relatively large in volume, and increase in amount of refrigerant can be prevented.

[0072] The heating operation as the second operation mode will now be described. In this case, initially, in indoor unit 5 (indoor heat exchanger 27), gas refrigerant flows through gas distributors 35a and 35b to appropriately distribute gas, and thereafter it exchanges heat in corresponding indoor first heat exchanger 29 or indoor second heat exchanger 31 to become liquid refrigerant, and resultant liquid refrigerant flows through gas-liquid two-phase distributors 33a and 33b.

[0073] Then, in outdoor unit 3 (outdoor heat exchanger 11), refrigerant in the gas-liquid two-phase state flows through gas-liquid two-phase distributors 21a and 21b to uniformly distribute refrigerant in the gas-liquid two-phase state, and thereafter it exchanges heat in corresponding outdoor first heat exchanger 13 or outdoor second heat exchanger 15 to become gas refrigerant, and resultant gas refrigerant flows through gas distributors 23a and 23b.

[0074] Thus, the flow of refrigerant in the gas-liquid two-phase state through the gas distributor relatively large in volume and resultant failure in uniform distribution of refrigerant as in the second case in the comparative example do not occur, and performance as the evaporator can be ensured. Gas refrigerant does not flow through the gas-liquid two-phase distributor and pressure loss of refrigerant can be reduced. Furthermore, gas refrigerant flows not through the gas-liquid two-phase distributor but through the gas distributor, and hence excessive increase in pressure can be suppressed.

[0075] In air-conditioner 1 described above, the orientation during the cooling operation, of the flow of refrigerant through refrigerant pipe 41 that connects indoor unit 5 and outdoor unit 3 to each other is reverse to that during the heating operation. Thus, the diameter of refrigerant pipe 41 that connects indoor unit 5 and outdoor unit 3 to each other does not have to be increased in consideration of the cooling operation as in the air-conditioner in the comparative example, and liquid refrigerant remaining in refrigerant pipe 41 during the heating operation is also suppressed and increase in amount of refrigerant can be suppressed.

[0076] An effect of the counterflow in air-conditioner 1 described above will now be described with reference to outdoor heat exchanger 11 by way of example.

[0077] The effect in the cooling operation as the first operation mode will initially be described. Fig. 5 shows graphs GR1 and GR2 of a temperature of refrigerant that flows through outdoor heat exchanger 11 during the cooling operation and graphs GA1 and GA2 of a temperature of air that passes through outdoor heat exchanger 11. The upper tier shows also outdoor heat exchanger 11 and the like shown in Fig. 3.

[0078] As shown in Fig. 5, graph GR1 shows relation between a flow (direction) of air and a temperature of refrigerant that flows through outdoor first heat exchang-

er 13. The temperature of refrigerant immediately before it flows into outdoor first heat exchanger 13 is a temperature T_{Ain} and the temperature of refrigerant immediately after it flows through outdoor first heat exchanger 13 is a temperature T_{Aout} .

[0079] Graph GR2 shows relation between a flow (direction) of air and a temperature of refrigerant that flows through outdoor second heat exchanger 15. The temperature of refrigerant immediately before it flows into outdoor second heat exchanger 15 is a temperature T_{Bin} and the temperature of refrigerant immediately after it flows through outdoor second heat exchanger 15 is a temperature T_{Bout} .

[0080] Graph GA1 shows relation between a flow (direction) of air and a temperature of air that passes through outdoor first heat exchanger 13. Graph GA2 shows relation between a flow (direction) of air and a temperature of air that passes through outdoor second heat exchanger 15.

[0081] As shown in the upper tier in Fig. 5, in outdoor first heat exchanger 13 in outdoor heat exchanger 11, refrigerant flows as the counterflow that flows as being opposed to the flow of air (arrow YA). In outdoor second heat exchanger 15, refrigerant flows as the parallel flow that flows in parallel to the flow of air (arrow YA).

[0082] The non-azeotropic refrigerant mixture has a property to decrease in temperature as a degree of dryness lowers in a two-phase state. As shown in graph GR1, refrigerant that flows as the counterflow decreases in temperature as it flows in an orientation opposite to the direction of flow of air. As shown in graph GR2, on the other hand, refrigerant that flows as the parallel flow decreases in temperature as it flows in a direction the same as the direction of flow of air.

[0083] As shown in graph GA1 and graph GA2, air that passes through outdoor heat exchanger 11 increases in temperature as it exchanges heat with refrigerant. Therefore, difference in temperature between refrigerant that flows as the parallel flow and air gradually become smaller. Refrigerant that flows as the counterflow can ensure the difference in temperature from air, as compared with refrigerant that flows as the parallel flow.

[0084] Thus, in outdoor heat exchanger 11, the temperature of air that passes through outdoor first heat exchanger 13 is higher than the temperature of air that passes through outdoor second heat exchanger 15, and in outdoor heat exchanger 11, an amount of heat exchange between refrigerant and air increases in particular in outdoor first heat exchanger 13. Consequently, performance of air-conditioner 1 during the cooling operation can be improved.

[0085] The effect in the heating operation as the second operation mode will now be described. Fig. 6 shows graphs GR1 and GR2 of a temperature of refrigerant that flows through outdoor heat exchanger 11 during the heating operation and graphs GA1 and GA2 of a temperature of air that passes through outdoor heat exchanger 11. The upper tier shows also outdoor heat exchanger 11

and the like shown in Fig. 4.

[0086] As shown in Fig. 6, graph GR1 shows relation between a flow (direction) of air and a temperature of refrigerant that flows through outdoor first heat exchanger 13. The temperature of refrigerant immediately before it flows into outdoor first heat exchanger 13 is temperature T_{Ain} and the temperature of refrigerant immediately after it flows through outdoor first heat exchanger 13 is temperature T_{Aout} .

[0087] Graph GR2 shows relation between a flow (direction) of air and a temperature of refrigerant that flows through outdoor second heat exchanger 15. The temperature of refrigerant immediately before it flows into outdoor second heat exchanger 15 is temperature T_{Bin} and the temperature of refrigerant immediately after it flows through outdoor second heat exchanger 15 is temperature T_{Bout} .

[0088] Graph GA1 shows relation between a flow (direction) of air and a temperature of air that passes through outdoor first heat exchanger 13. Graph GA2 shows relation between a flow (direction) of air and a temperature of air that passes through outdoor second heat exchanger 15.

[0089] As shown in the upper tier in Fig. 6, in outdoor first heat exchanger 13 in outdoor heat exchanger 11, refrigerant flows as the parallel flow that flows in parallel to the flow of air (arrow YA). In outdoor second heat exchanger 15, refrigerant flows as the counterflow that flows as being opposed to the flow of air (arrow YA).

[0090] As described above, difference in temperature between refrigerant that flows as the parallel flow and air gradually become smaller. Refrigerant that flows as the counterflow can ensure the difference in temperature from air as compared with refrigerant that flows as the parallel flow.

[0091] Thus, in outdoor heat exchanger 11, the temperature of air that passes through outdoor second heat exchanger 15 is lower than the temperature of air that passes through outdoor first heat exchanger 13, and in outdoor heat exchanger 11, an amount of heat exchange between refrigerant and air increases in particular in outdoor second heat exchanger 15. Consequently, performance of air-conditioner 1 during the heating operation can be improved.

[0092] In air-conditioner 1 described above, outdoor first heat exchanger 13 and outdoor second heat exchanger 15 are connected in parallel with respect to refrigeration cycle circuit 51. In addition, indoor first heat exchanger 13 and outdoor second heat exchanger 15 are connected in parallel with respect to refrigeration cycle circuit 51.

[0093] As shown in Fig. 7, in order to uniformly distribute (merge) refrigerant to outdoor first heat exchanger 13 and outdoor second heat exchanger 15, a Y-shaped or T-shaped branch portion 61 may be provided at each of branch and merge point P1 and branch and merge point P2. Similarly, in order to uniformly distribute (merge) refrigerant to indoor first heat exchanger 29 and indoor

second heat exchanger 31, Y-shaped or T-shaped branch portion 61 may be provided at each of branch and merge point P3 and branch and merge point P4.

Second Embodiment.

[0094] An exemplary air-conditioner according to a second embodiment will be described. As shown in Figs. 8 and 9, outdoor heat exchanger 11 is provided with an outdoor third heat exchanger 17 as a third heat exchanger in addition to outdoor first heat exchanger 13 and outdoor second heat exchanger 15. Outdoor third heat exchanger 17 is connected in series between expansion valve 19 and outdoor first heat exchanger 13 and outdoor second heat exchanger 15 connected in parallel, with respect to refrigeration cycle circuit 51. Outdoor first heat exchanger 13 is arranged below outdoor first heat exchanger 13 and outdoor second heat exchanger 15.

[0095] The number of refrigerant flow paths in outdoor first heat exchanger 13 is the first number of refrigerant flow paths, the number of refrigerant flow paths in outdoor second heat exchanger 15 is the second number of refrigerant flow paths, and the number of refrigerant flow paths in outdoor third heat exchanger 17 is the third number of refrigerant flow paths. The third number of refrigerant flow paths is smaller than the first number of refrigerant flow paths and the second number of refrigerant flow paths.

[0096] Outdoor third heat exchanger 17 includes a fifth part 17a and a sixth part 17b. Fifth part 17a and sixth part 17b are connected in series. Fifth part 17a and sixth part 17b are arranged along the direction of passage of air (see arrow YA). Fifth part 17a is arranged on the windward side. Sixth part 17b is arranged on the leeward side.

[0097] A gas-liquid two-phase distributor 21c as a third gas-liquid two-phase distributor is connected on a side opposite to a side where sixth part 17b is connected, with respect to fifth part 17a. A gas distributor 23c as a third gas distributor is connected on a side opposite to a side where fifth part 17a is connected, with respect to sixth part 17b.

[0098] Air-conditioner 1 is provided with a flow path R5 as a third flow path including a portion through which gas distributor 23c sixth part 17b, fifth part 17a, and gas-liquid two-phase distributor 21c are sequentially connected. Since the construction is otherwise similar to the construction of air-conditioner 1 shown in Figs. 1 and 2, identical members have identical reference characters allotted and description thereof will not be repeated unless necessary.

[0099] An operation (a flow of refrigerant) of air-conditioner 1 (refrigeration cycle circuit 51) described above will now be described. Operations which are duplication of those in air-conditioner 1 according to the first embodiment will be described as being simplified.

(Cooling Operation)

[0100] The cooling operation will initially be described. As shown in Figs. 8 and 10, high-temperature and high-pressure gas refrigerant discharged from compressor 7 is sent through four-way valve 9 to outdoor unit 3. Refrigerant sent to outdoor unit 3 flows through outdoor first heat exchanger 13 (flow path R1) and outdoor second heat exchanger 15 (flow path R2) in parallel and thereafter flows through indoor third heat exchanger 17 (flow path R5).

[0101] In outdoor unit 3, refrigerant flows in parallel through flow path R1 and flow path R2, flows of refrigerant thereafter merge at branch and merge point P2, and merged refrigerant flows through flow path R5. In flow path R5, refrigerant successively flows through gas distributor 23c, sixth part 17b, fifth part 17a, and gas-liquid two-phase distributor 21c. In outdoor third heat exchanger 17, refrigerant flows through sixth part 17b arranged on the leeward side and thereafter flows as the counter-flow that flows through fifth part 17a arranged on the windward side.

[0102] Refrigerant (high-pressure liquid refrigerant) that flows through outdoor unit 3 passes through expansion valve 19 to become refrigerant in the gas-liquid two-phase state containing low-pressure gas refrigerant and liquid refrigerant. Low-pressure refrigerant in the gas-liquid two-phase state flows into indoor unit 5 and becomes low-pressure gas refrigerant, and resultant low-pressure gas refrigerant flows into compressor 7. This cycle is repeated hereafter.

(Heating Operation)

[0103] The heating operation will now be described. As shown in Figs. 8 and 11, high-temperature and high-pressure gas refrigerant discharged from compressor 7 flows into indoor unit 5 through four-way valve 9 and becomes high-pressure liquid refrigerant. High-pressure liquid refrigerant is sent to outdoor unit 3 and passes through expansion valve 19 to become refrigerant in the gas-liquid two-phase state containing low-pressure gas refrigerant and liquid refrigerant.

[0104] Refrigerant in the gas-liquid two-phase state flows through the outdoor third heat exchanger (flow path R1) and thereafter flows through outdoor first heat exchanger 13 (flow path R1) and outdoor second heat exchanger 15 (flow path R2) in parallel. In flow path R5, refrigerant successively flows through gas-liquid two-phase distributor 21c, fifth part 17a, sixth part 17b, and gas distributor 23c. In outdoor third heat exchanger 17, refrigerant flows through fifth part 17a arranged on the windward side and thereafter flows as the parallel flow that flows through sixth part 17b arranged on the leeward side.

[0105] Low-pressure gas refrigerant that flows through outdoor third heat exchanger 17 and the like and is sent out of outdoor unit 3 flows into compressor 7 through

four-way valve 9. This cycle is repeated hereafter.

[0106] Air-conditioner 1 described above obtains an effect of suppression of pressure loss of refrigerant and an effect of suppression of increase in amount of refrigerant, as described in connection with air-conditioner 1 according to the first embodiment. Air-conditioner 1 according to the second embodiment further obtains an effect as follows.

[0107] The effect in the case of the cooling operation will now be described. Fig. 12 shows graphs GR1, GR2, and GR3 of a temperature of refrigerant that flows through outdoor heat exchanger 11 in the cooling operation and graphs GA1, GA2, and GA3 of a temperature of air that passes through outdoor heat exchanger 11. The upper tier shows also outdoor heat exchanger 11 and the like shown in Fig. 10.

[0108] As shown in Fig. 12, graph GR1 shows relation between a flow (direction) of air and a temperature of refrigerant that flows through outdoor first heat exchanger 13. The temperature of refrigerant immediately before it flows into outdoor first heat exchanger 13 is temperature T_{Ain} and the temperature of refrigerant immediately after it flows through outdoor first heat exchanger 13 is temperature T_{Aout} .

[0109] Graph GR2 shows relation between a flow (direction) of air and a temperature of refrigerant that flows through outdoor second heat exchanger 15. The temperature of refrigerant immediately before it flows into outdoor second heat exchanger 15 is temperature T_{Bin} and the temperature of refrigerant immediately after it flows through outdoor second heat exchanger 15 is temperature T_{Bout} .

[0110] Graph GR3 shows relation between a flow (direction) of air and a temperature of refrigerant that flows through outdoor third heat exchanger 17. The temperature of refrigerant immediately before it flows into outdoor third heat exchanger 17 is a temperature T_{Cin} and the temperature of refrigerant immediately after it flows through outdoor third heat exchanger 17 is a temperature T_{Cout} .

[0111] Graph GA1 shows relation between a flow (direction) of air and a temperature of air that passes through outdoor first heat exchanger 13. Graph GA2 shows relation between a flow (direction) of air and a temperature of air that passes through outdoor second heat exchanger 15. Graph GA3 shows relation between a flow (direction) of air and a temperature of air that passes through outdoor third heat exchanger 17.

[0112] As shown in the upper tier in Fig. 12, in outdoor first heat exchanger 13 in outdoor heat exchanger 11, refrigerant flows as the counterflow that flows as being opposed to the flow of air (arrow YA). In outdoor second heat exchanger 15, refrigerant flows as the parallel flow that flows in parallel to the flow of air (arrow YA). In outdoor third heat exchanger 17, refrigerant flows as the counterflow that flows as being opposed to the flow of air (arrow YA).

[0113] As shown in graphs GA1 to GA3, on the other

hand, air that passes through outdoor heat exchanger 11 increases in temperature as it exchanges heat with refrigerant. Therefore, difference in temperature between refrigerant that flows as the parallel flow and air gradually become smaller. Refrigerant that flows as the counterflow can ensure the difference in temperature from air, as compared with refrigerant that flows as the parallel flow.

[0114] Refrigerant that flows through outdoor second heat exchanger 15 as the parallel flow flows into outdoor third heat exchanger 17, together with refrigerant that flows through outdoor first heat exchanger 13. In outdoor third heat exchanger 17, refrigerant flows as the counterflow.

[0115] Specifically, refrigerant containing refrigerant that has flowed through outdoor second heat exchanger 15 to gradually decrease the temperature difference between refrigerant and air flows as the counterflow in outdoor third heat exchanger 17. The temperature difference between refrigerant and air can thus be ensured, and the amount of heat exchange between refrigerant and air in outdoor third heat exchanger 17 can be increased. Consequently, performance during the cooling operation can further be improved.

[0116] The effect in the case of the heating operation will now be described. Fig. 13 shows graphs GR1, GR2, and GR3 of a temperature of refrigerant that flows through outdoor heat exchanger 11 during the heating operation and graphs GA1, GA2, and GA3 of a temperature of air that passes through outdoor heat exchanger 11. The upper tier shows also outdoor heat exchanger 11 and the like shown in Fig. 11.

[0117] As shown in Fig. 13, graph GR1 shows relation between a flow (direction) of air and a temperature of refrigerant that flows through outdoor first heat exchanger 13. The temperature of refrigerant immediately before it flows into outdoor first heat exchanger 13 is temperature T_{Ain} and the temperature of refrigerant immediately after it flows through outdoor first heat exchanger 13 is temperature T_{Aout} .

[0118] Graph GR2 shows relation between a flow (direction) of air and a temperature of refrigerant that flows through outdoor second heat exchanger 15. The temperature of refrigerant immediately before it flows into outdoor second heat exchanger 15 is temperature T_{Bin} and the temperature of refrigerant immediately after it flows through outdoor second heat exchanger 15 is temperature T_{Bout} .

[0119] Graph GR3 shows relation between a flow (direction) of air and a temperature of refrigerant that flows through outdoor third heat exchanger 17. The temperature of refrigerant immediately before it flows into outdoor third heat exchanger 17 is temperature T_{Cin} and the temperature of refrigerant immediately after it flows through outdoor third heat exchanger 17 is temperature T_{Cout} .

[0120] Graph GA1 shows relation between a flow (direction) of air and a temperature of air that passes through outdoor first heat exchanger 13. Graph GA2

shows relation between a flow (direction) of air and a temperature of air that passes through outdoor second heat exchanger 15. Graph GA3 shows relation between a flow (direction) of air and a temperature of air that passes through outdoor third heat exchanger 17.

[0121] As shown in the upper tier in Fig. 13, in outdoor first heat exchanger 13 in outdoor heat exchanger 11, refrigerant flows as the parallel flow. In outdoor second heat exchanger 15, refrigerant flows as the counterflow. In outdoor third heat exchanger 17, refrigerant flows as the parallel flow.

[0122] As shown in graphs GA1 to GA3, on the other hand, air that passes through outdoor heat exchanger 11 decreases in temperature as it exchanges heat with refrigerant.

[0123] Refrigerant that is sent to outdoor unit 3 and passes through expansion valve 19 to be in the gas-liquid two-phase state flows through outdoor third heat exchanger 17, and thereafter flows in parallel through outdoor first heat exchanger 13 and outdoor second heat exchanger 15. In outdoor third heat exchanger 17, refrigerant in the gas-liquid two-phase state flows as the parallel flow.

[0124] The third number of refrigerant flow paths in outdoor third heat exchanger 17 is smaller than the first number of refrigerant flow paths in outdoor first heat exchanger 13 and the second number of refrigerant flow paths in outdoor second heat exchanger 15. Therefore, outdoor third heat exchanger 17 is relatively higher in pressure loss of refrigerant than outdoor first heat exchanger 13 and outdoor second heat exchanger 15.

[0125] The temperature of refrigerant (see graph GR3) that flows through outdoor third heat exchanger 17 is thus higher than the temperature of refrigerant (see graph GR1) that flows through outdoor first heat exchanger 13 and the temperature of refrigerant (see graph GR2) that flows through outdoor second heat exchanger 15.

[0126] Outdoor third heat exchanger 17 is arranged below outdoor first heat exchanger 13 and outdoor second heat exchanger 15. In the heating operation, condensation water attached to outdoor first heat exchanger 13 and outdoor second heat exchanger 15 flows down to outdoor third heat exchanger 17 arranged below and frost tends to grow in outdoor third heat exchanger 17.

[0127] As refrigerant higher in temperature than refrigerant that flows through outdoor first heat exchanger 13 and refrigerant that flows through outdoor second heat exchanger 15 flows through outdoor third heat exchanger 17, growth of frost in outdoor third heat exchanger 17 can be suppressed.

Third Embodiment.

[0128] An exemplary air-conditioner according to a third embodiment will be described. As shown in Figs. 14 and 15, an outdoor first flow rate regulation valve 25a and an outdoor second flow rate regulation valve 25b are arranged in outdoor unit 3.

[0129] Outdoor first flow rate regulation valve 25a is arranged in flow path R1. Outdoor first flow rate regulation valve 25a is arranged in a portion of flow path R1 between branch and merge point P2 and gas-liquid two-phase distributor 21a. Outdoor second flow rate regulation valve 25b is arranged in flow path R2. Outdoor second flow rate regulation valve 25b is arranged in a portion of flow path R2 between branch and merge point P2 and gas-liquid two-phase distributor 21b.

[0130] An indoor first flow rate regulation valve 37a and an indoor second flow rate regulation valve 37b are arranged in indoor unit 5. Indoor first flow rate regulation valve 37a is arranged in flow path R3. Indoor first flow rate regulation valve 37a is arranged in a portion of flow path R3 between branch and merge point P4 and gas-liquid two-phase distributor 33a. Indoor second flow rate regulation valve 37b is arranged in a portion of flow path R4 between branch and merge point P4 and gas-liquid two-phase distributor 33b.

[0131] For example, a solenoid valve or an electronic expansion valve can be employed as outdoor first flow rate regulation valve 25a, outdoor second flow rate regulation valve 25b, indoor first flow rate regulation valve 37a, and indoor second flow rate regulation valve 37b. When the electronic expansion valve is employed, expansion valve 19 does not have to be provided. Since the construction is otherwise similar to the construction of air-conditioner 1 shown in Figs. 1 and 2, identical members have identical reference characters allotted and description thereof will not be repeated unless necessary.

[0132] An operation (a flow of refrigerant) of air-conditioner 1 (refrigeration cycle circuit 51) described above will now be described. Operations which are duplication of those of air-conditioner 1 according to the first embodiment will be described as being simplified.

(Cooling Operation)

[0133] The cooling operation will initially be described. As shown in Figs. 14 and 16, high-temperature and high-pressure gas refrigerant discharged from compressor 7 is sent through four-way valve 9 to outdoor unit 3. Refrigerant sent to outdoor unit 3 flows in parallel through flow path R1 (outdoor first heat exchanger 13) and flow path R2 (outdoor second heat exchanger 15).

[0134] In flow path R1, refrigerant successively flows through gas distributor 23a, second part 13b, first part 13a, gas-liquid two-phase distributor 21a, and outdoor first flow rate regulation valve 25a. In outdoor first heat exchanger 13, refrigerant flows through second part 13b arranged on the leeward side and thereafter flows as the counterflow that flows through first part 13a arranged on the windward side.

[0135] In flow path R2, refrigerant successively flows through gas distributor 23b, third part 15a, fourth part 15b, gas-liquid two-phase distributor 21b, and outdoor second flow rate regulation valve 25b. In outdoor second heat exchanger 15, refrigerant flows through third part

15a arranged on the windward side and thereafter flows as the parallel flow that flows through fourth part 15b arranged on the leeward side.

[0136] Refrigerant that flows through flow path R1 and refrigerant that flows through flow path R2 merge, and merged refrigerant passes through expansion valve 19 to become refrigerant in the gas-liquid two-phase state containing low-pressure gas refrigerant and liquid refrigerant. Resultant low-pressure refrigerant in the gas-liquid two-phase state is sent to indoor unit 5. Refrigerant sent to indoor unit 5 flows through flow path R3 (indoor first heat exchanger 29) and flow path R4 (indoor second heat exchanger 31) in parallel.

[0137] In flow path R3, refrigerant successively flows through indoor first flow rate regulation valve 37a, gas-liquid two-phase distributor 33a, indoor first heat exchanger 29, and gas distributor 35a. In indoor first heat exchanger 29, refrigerant flows as the parallel flow. In flow path R4, refrigerant successively flows through indoor second flow rate regulation valve 37b, gas-liquid two-phase distributor 33b, indoor second heat exchanger 31, and gas distributor 35b. In indoor second heat exchanger 31, refrigerant flows as the counterflow.

[0138] Refrigerant that flows through flow path R3 and refrigerant that flows through flow path R4 merge, and merged refrigerant flows into compressor 7. This cycle is repeated hereafter.

(Heating Operation)

[0139] The heating operation will now be described. As shown in Figs. 14 and 17, high-temperature and high-pressure gas refrigerant discharged from compressor 7 flows into indoor unit 5 through four-way valve 9. In indoor unit 5, refrigerant flows through flow path R3 (indoor first heat exchanger 29) and flow path R4 (indoor second heat exchanger 31) in parallel.

[0140] In flow path R3, refrigerant successively flows through gas distributor 35a, indoor first heat exchanger 29, gas-liquid two-phase distributor 33a, and indoor first flow rate regulation valve 37a. In indoor first heat exchanger 29, refrigerant flows as the counterflow. In flow path R4, refrigerant successively flows through gas distributor 35b, indoor second heat exchanger 31, gas-liquid two-phase distributor 33b, and indoor second flow rate regulation valve 37b. In indoor second heat exchanger 31, refrigerant flows as the parallel flow.

[0141] Refrigerant that flows through flow path R3 and refrigerant that flows through flow path R4 merge, and merged refrigerant is sent to outdoor unit 3 and passes through expansion valve 19 to become refrigerant in the gas-liquid two-phase state containing low-pressure gas refrigerant and liquid refrigerant. Refrigerant in the gas-liquid two-phase state flows through flow path R1 (outdoor first heat exchanger 13) and flow path R2 (outdoor second heat exchanger 15) in parallel.

[0142] In flow path R1, refrigerant successively flows through outdoor first flow rate regulation valve 25a, gas-

liquid two-phase distributor 21a, first part 13a, second part 13b, and gas distributor 23a. In outdoor first heat exchanger 13, refrigerant flows as the parallel flow. In flow path R2, refrigerant successively flows through outdoor second flow rate regulation valve 25b, gas-liquid two-phase distributor 21b, fourth part 15b, third part 15a, and gas distributor 23b. In outdoor second heat exchanger 15, refrigerant flows as the counterflow.

[0143] Refrigerant that flows through flow path R1 and refrigerant that flows through flow path R2 merge, and merged refrigerant flows into compressor 7 through four-way valve 9. This cycle is repeated hereafter.

[0144] Air-conditioner 1 described above obtains an effect of suppression of pressure loss of refrigerant and an effect of suppression of increase in amount of refrigerant, as described in connection with air-conditioner 1 according to the first embodiment. Air-conditioner 1 according to the third embodiment further obtains an effect as follows.

[0145] The effect in the case of the cooling operation will initially be described. Fig. 18 shows graphs GR1 and GR2 of a temperature of refrigerant that flows through outdoor heat exchanger 11 during the cooling operation and graphs GA1 and GA2 of a temperature of air that passes through outdoor heat exchanger 11. The upper tier shows also outdoor heat exchanger 11 and the like shown in Fig. 16.

[0146] As shown in Fig. 18, graph GR1 shows relation between a flow (direction) of air and a temperature of refrigerant that flows through outdoor first heat exchanger 13. The temperature of refrigerant immediately before it flows into outdoor first heat exchanger 13 is temperature TA_{in} and the temperature of refrigerant immediately after it flows through outdoor first heat exchanger 13 is temperature TA_{out} .

[0147] Graph GR2 shows relation between a flow (direction) of air and a temperature of refrigerant that flows through outdoor second heat exchanger 15. The temperature of refrigerant immediately before it flows into outdoor second heat exchanger 15 is temperature TB_{in} and the temperature of refrigerant immediately after it flows through outdoor second heat exchanger 15 is temperature TB_{out} .

[0148] Graph GA1 shows relation between a flow (direction) of air and a temperature of air that passes through outdoor first heat exchanger 13. Graph GA2 shows relation between a flow (direction) of air and a temperature of air that passes through outdoor second heat exchanger 15.

[0149] As shown in the upper tier in Fig. 18, in outdoor first heat exchanger 13, refrigerant flows as the counterflow. In outdoor second heat exchanger 15, refrigerant flows as the parallel flow.

[0150] As shown in graphs GA1 and GA2, on the other hand, air that passes through outdoor heat exchanger 11 increases in temperature as it exchanges heat with refrigerant. Therefore, difference in temperature between refrigerant that flows as the parallel flow and air

gradually becomes smaller. Refrigerant that flows as the counterflow ensures the difference in temperature from air, as compared with refrigerant that flows as the parallel flow.

[0151] In air-conditioner 1 described above, by regulating outdoor second flow rate regulation valve 25b, a flow rate of refrigerant that flows as the parallel flow through outdoor second heat exchanger 15 can be lowered, and accordingly the flow rate of refrigerant that flows through outdoor first heat exchanger 13 can accordingly be increased.

[0152] Therefore, temperature TBout of refrigerant immediately after it flows through outdoor second heat exchanger 15 is lower than in an example where outdoor first flow rate regulation valve 25a and outdoor second flow rate regulation valve 25b are not provided (see Fig. 5). Temperature TAout of refrigerant immediately after it flows through outdoor first heat exchanger 13 is higher than in the example where outdoor first flow rate regulation valve 25a and outdoor second flow rate regulation valve 25b are not provided (see Fig. 5).

[0153] This means that outdoor second flow rate regulation valve 25b and the like can decrease a difference between temperature TAout and temperature TBout. Therefore, by regulating the flow rate of refrigerant with the use of outdoor second flow rate regulation valve 25b and the like such that temperature TAout (outlet side enthalpy) of refrigerant immediately after it flows through outdoor first heat exchanger 13 is substantially the same as temperature TBout (outlet side enthalpy) of refrigerant immediately after it flows through outdoor second heat exchanger 15, heat transfer performance of outdoor heat exchanger 11 can be improved.

[0154] The effect in the case of the heating operation will now be described. Fig. 19 shows graphs GR1 and GR2 of a temperature of refrigerant that flows through outdoor heat exchanger 11 during the heating operation and graphs GA1 and GA2 of a temperature of air that passes through outdoor heat exchanger 11. The upper tier shows also outdoor heat exchanger 11 and the like shown in Fig. 17.

[0155] As shown in Fig. 19, graph GR1 shows relation between a flow (direction) of air and a temperature of refrigerant that flows through outdoor first heat exchanger 13. The temperature of refrigerant immediately before it flows into outdoor first heat exchanger 13 is temperature TAin and the temperature of refrigerant immediately after it flows through outdoor first heat exchanger 13 is temperature TAout.

[0156] Graph GR2 shows relation between a flow (direction) of air and a temperature of refrigerant that flows through outdoor second heat exchanger 15. The temperature of refrigerant immediately before it flows into outdoor second heat exchanger 15 is temperature TBin and the temperature of refrigerant immediately after it flows through outdoor second heat exchanger 15 is temperature TBout.

[0157] Graph GA1 shows relation between a flow (di-

rection) of air and a temperature of air that passes through outdoor first heat exchanger 13. Graph GA2 shows relation between a flow (direction) of air and a temperature of air that passes through outdoor second heat exchanger 15.

[0158] As shown in the upper tier in Fig. 19, in outdoor first heat exchanger 13, refrigerant flows as the parallel flow. In outdoor second heat exchanger 15, refrigerant flows as the counterflow.

[0159] As shown in graphs GA1 and GA2, on the other hand, air that passes through outdoor heat exchanger 11 increases in temperature as it exchanges heat with refrigerant. Therefore, difference in temperature between refrigerant that flows as the parallel flow and air gradually becomes smaller. Refrigerant that flows as the counterflow ensures the difference in temperature from air, as compared with refrigerant that flows as the parallel flow.

[0160] In air-conditioner 1 described above, by regulating outdoor first flow rate regulation valve 25a, a flow rate of refrigerant that flows as the parallel flow through outdoor first heat exchanger 13 can be lowered, and the flow rate of refrigerant that flows through outdoor second heat exchanger 15 can accordingly be increased.

[0161] Therefore, temperature TAout of refrigerant immediately after it flows through outdoor first heat exchanger 13 is higher than in the example where outdoor first flow rate regulation valve 25a and outdoor second flow rate regulation valve 25b are not provided (see Fig. 5). Temperature TBout of refrigerant immediately after it flows through outdoor second heat exchanger 15 is lower than in the example where outdoor first flow rate regulation valve 25a and outdoor second flow rate regulation valve 25b are not provided (see Fig. 5).

[0162] This means that outdoor first flow rate regulation valve 25a and the like can decrease difference between temperature TAout and temperature TBout. Therefore, by regulating the flow rate of refrigerant with the use of outdoor first flow rate regulation valve 25a and the like such that temperature TAout (outlet side enthalpy) of refrigerant immediately after it flows through outdoor first heat exchanger 13 is substantially the same as temperature TBout (outlet side enthalpy) of refrigerant immediately after it flows through outdoor second heat exchanger 15, heat transfer performance of outdoor heat exchanger 11 can be improved.

[0163] In order to more accurately measure the temperature of refrigerant, a temperature sensor such as a thermistor may be provided in refrigerant pipe 41.

[0164] As shown in Fig. 15, desirably, in outdoor first heat exchanger 13, a temperature sensor T1 is provided in a portion S1 of refrigerant pipe 41 located opposite to the side where first part 13a is connected, with respect to gas-liquid two-phase distributor 21a, and a temperature sensor T2 is arranged in a portion S2 of refrigerant pipe 41 located opposite to the side where second part 13b is connected, with respect to gas distributor 23a.

[0165] In outdoor second heat exchanger 15, desira-

bly, a temperature sensor T4 is provided in a portion S4 of refrigerant pipe 41 located opposite to the side where fourth part 15b is connected, with respect to gas-liquid two-phase distributor 21b, and a temperature sensor T3 is provided in a portion S3 of refrigerant pipe 41 located opposite to the side where third part 15a is connected, with respect to gas distributor 23b.

[0166] For example, a pressure sensor may be provided in refrigerant pipe 41 (portions S1 to S4) other than temperature sensors T1 to T4. Each outlet side enthalpy can more accurately be calculated with the use of the pressure sensor.

[0167] Though a two-row structure including two rows of heat transfer tubes where first part 13a (third part 15a) and second part 13b (fourth part 15b) are arranged in the direction of passage of air is exemplified as outdoor heat exchanger 11 or the like, a multiple-row structure including three or more rows may be applicable. A circular tube having a circular cross-section or a low-profile tube having a low-profile cross-section may be applicable as the heat transfer tube arranged in outdoor heat exchanger 11 or the like.

[0168] Though a function and effect of air-conditioner 1 according to each embodiment is described representatively with reference to outdoor heat exchanger 11 in outdoor unit 3, indoor heat exchanger 27 in indoor unit 5 also obtains an effect similar to that of outdoor heat exchanger 11. Furthermore, at least one of outdoor heat exchanger 11 and indoor heat exchanger 27 should only be applied as the first heat exchanger and the second heat exchanger.

[0169] Air-conditioner 1 described in each embodiment can variously be combined as necessary.

[0170] The embodiments disclosed herein are illustrative and restriction thereto is not intended. The present disclosure is defined by the terms of the claims rather than the scope described above, and is intended to include any modifications within the scope and meaning equivalent to the terms of the claims.

INDUSTRIAL APPLICABILITY

[0171] The present disclosure is effectively made use of as an air-conditioner where a non-azeotropic refrigerant mixture is used as refrigerant.

REFERENCE SIGNS LIST

[0172] 1 air-conditioner; 3 outdoor unit; 5 indoor unit; 7 compressor; 9 four-way valve; 11 outdoor heat exchanger; 13 outdoor first heat exchanger; 13a first part; 13b second part; 21a gas-liquid two-phase distributor; 23a gas distributor; 15 outdoor second heat exchanger; 15a third part; 15b fourth part; 21b gas-liquid two-phase distributor; 23b gas distributor; 17 outdoor third heat exchanger; 17a fifth part; 17b sixth part; 21c gas-liquid two-phase distributor; 23c gas distributor; 19 expansion valve; 25a outdoor first flow rate regulation valve; 25b

outdoor second flow rate regulation valve; 27 indoor heat exchanger; 29 indoor first heat exchanger; 33a gas-liquid two-phase distributor; 35a gas distributor; 31 indoor second heat exchanger; 33b gas-liquid two-phase distributor; 35b gas distributor; 37a indoor first flow rate regulation valve; 37b indoor second flow rate regulation valve; 41 refrigerant pipe; 43 non-azeotropic refrigerant mixture; 51 refrigeration cycle circuit; 61 branch portion; P1, P2, P3, P4 branch and merge point; R1, R2, R3, R4, R5 flow path; TAin, TAout, TBin, TBout, TCin, TCout temperature; GR1, GR2, GR3, GA1, GA2, GA3 graph; S1, S2, S3, S4 portion; T1, T2, T3, T4 temperature sensor; YA, YB arrow

Claims

1. An air-conditioner comprising:

a refrigeration cycle circuit comprising an outdoor unit and an indoor unit, a non-azeotropic refrigerant mixture circulating through the refrigeration cycle circuit, wherein at least one of the outdoor unit and the indoor unit comprises

a first heat exchanger comprising a first part and a second part connected in series,
a second heat exchanger comprising a third part and a fourth part connected in series,
a first gas-liquid two-phase distributor connected on a side opposite to a side where the second part is connected, with respect to the first part,
a first gas distributor connected on a side opposite to a side where the first part is connected, with respect to the second part,
a second gas distributor connected on a side opposite to a side where the fourth part is connected, with respect to the third part,
a second gas-liquid two-phase distributor connected on a side opposite to a side where the third part is connected, with respect to the fourth part,
a first flow path comprising a portion through which the first gas distributor, the second part, the first part, and the first gas-liquid two-phase distributor are sequentially connected, and
a second flow path comprising a portion through which the second gas distributor, the third part, the fourth part, and the second gas-liquid two-phase distributor are sequentially connected,

the first flow path where the first heat exchanger is arranged and the second flow path where the second heat exchanger is arranged are con-

connected in parallel with respect to the refrigeration cycle circuit in such a manner that the first gas-liquid two-phase distributor and the second gas-liquid two-phase distributor are connected and the first gas distributor and the second gas distributor are connected,
the air-conditioner has a first operation mode in which the first heat exchanger and the second heat exchanger function as a condenser and a second operation mode in which the first heat exchanger and the second heat exchanger function as an evaporator, and
with respect to a direction of passage of air that passes through the first heat exchanger and the second heat exchanger,

the first part is arranged on a windward side,
the second part is arranged on a leeward side,
the third part is arranged on the windward side, and
the fourth part is arranged on the leeward side.

2. The air-conditioner according to claim 1, wherein

in the first operation mode,
in the first flow path, the non-azeotropic refrigerant mixture flows as a counterflow that sequentially flows through the first gas distributor, the second part arranged on the leeward side, the first part arranged on the windward side, and the first gas-liquid two-phase distributor, and
in the second flow path, the non-azeotropic refrigerant mixture flows as a parallel flow that sequentially flows through the second gas distributor, the third part arranged on the windward side, the fourth part arranged on the leeward side, and the second gas-liquid two-phase distributor.

3. The air-conditioner according to claim 1 or 2, wherein

in the second operation mode,
in the first flow path, the non-azeotropic refrigerant mixture flows as a parallel flow that sequentially flows through the first gas-liquid two-phase distributor, the first part arranged on the windward side, the second part arranged on the leeward side, and the first gas distributor, and
in the second flow path, the non-azeotropic refrigerant mixture flows as a counterflow that sequentially flows through the second gas-liquid two-phase distributor, the fourth part arranged on the leeward side, the third part arranged on the windward side, and the second gas distributor.

4. The air-conditioner according to claim 2 or 3, comprising:

a third heat exchanger comprising a fifth part and a sixth part connected in series;
a third gas-liquid two-phase distributor connected to the fifth part on a side opposite to a side where the sixth part is connected;
a third gas distributor connected to the sixth part on a side opposite to a side where the fifth part is connected;
a third flow path comprising a portion through which the third gas-liquid two-phase distributor, the fifth part, the sixth part, and the third gas distributor are sequentially connected; and
an expansion valve arranged between the outdoor unit and the indoor unit in the refrigeration cycle circuit, wherein
the third flow path where the third heat exchanger is arranged is connected in series between the expansion valve and the first flow path and the second flow path connected in parallel, with respect to the direction of passage of air that passes through the third heat exchanger,

the fifth part is arranged on the windward side, and
the sixth part is arranged on the leeward side,

the number of refrigerant flow paths in the first heat exchanger where the non-azeotropic refrigerant mixture flows is a first number of refrigerant flow paths,
the number of refrigerant flow paths in the second heat exchanger where the non-azeotropic refrigerant mixture flows is a second number of refrigerant flow paths,
the number of refrigerant flow paths in the third heat exchanger where the non-azeotropic refrigerant mixture flows is a third number of refrigerant flow paths,
the third number of refrigerant flow paths is smaller than the first number of refrigerant flow paths and the second number of refrigerant flow paths, and
the third heat exchanger is arranged below the first heat exchanger and the second heat exchanger.

5. The air-conditioner according to claim 4, wherein

in the first operation mode, the non-azeotropic refrigerant mixture flows from the first flow path and the second flow path connected in parallel to the third flow path, and
in the third flow path, the non-azeotropic refrigerant mixture flows as a counterflow that se-

quentially flows through the third gas distributor, the sixth part, the fifth part, and the third gas-liquid two-phase distributor.

6. The air-conditioner according to claim 4 or 5, wherein 5

in the second operation mode, the non-azeotropic refrigerant mixture flows from the third flow path to the first flow path and the second flow path connected in parallel, and 10
in the third flow path, the non-azeotropic refrigerant mixture flows as a parallel flow that sequentially flows through the third gas-liquid two-phase distributor, the fifth part, the sixth part, and the third gas distributor. 15

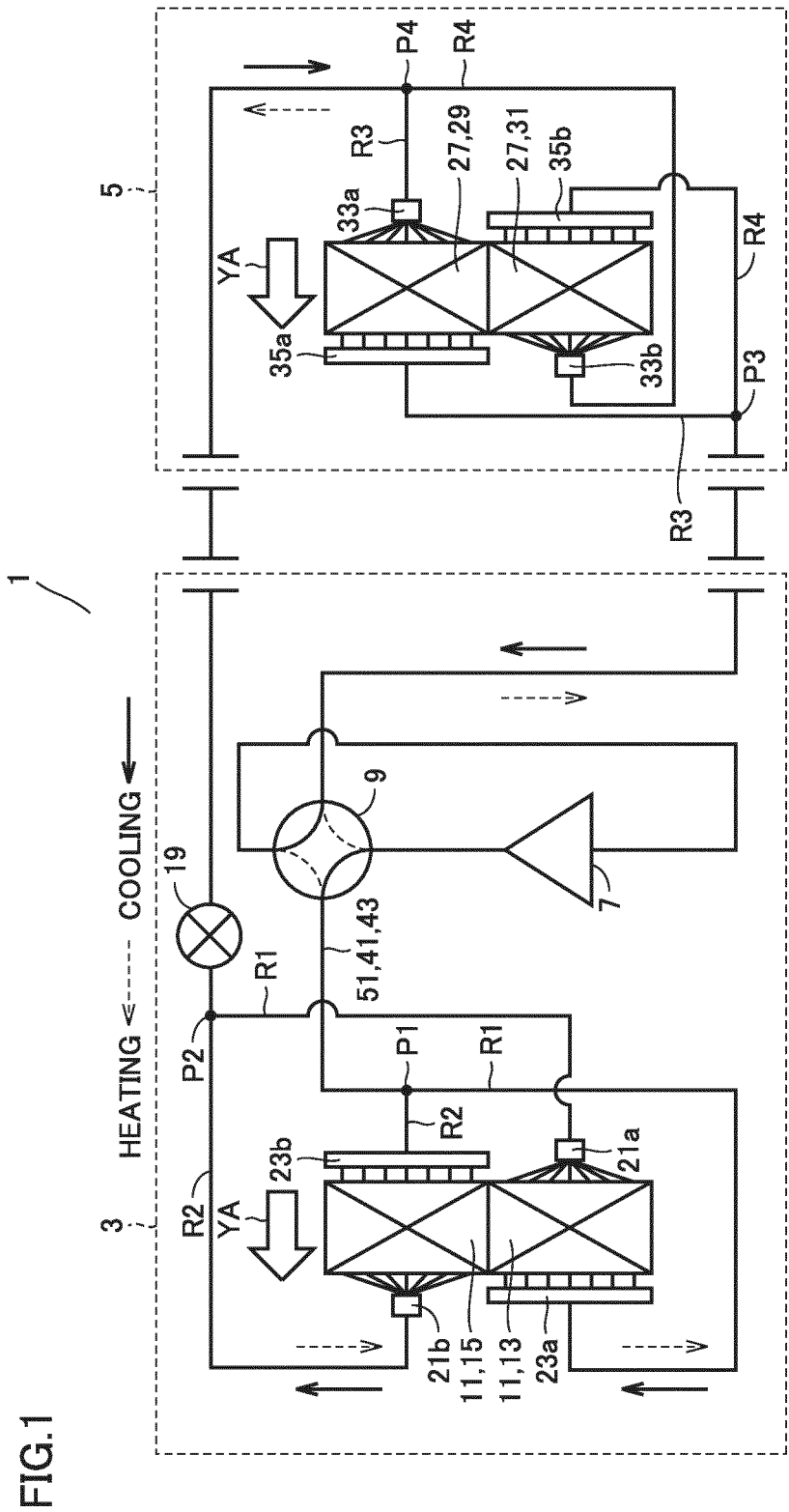
7. The air-conditioner according to any one of claims 1 to 6, comprising:

a first flow rate regulation valve arranged in a portion of the first flow path located opposite to the side where the first part is connected, with respect to the first gas-liquid two-phase distributor; and 20
a second flow rate regulation valve arranged in a portion of the second flow path located opposite to the side where the fourth part is connected, with respect to the second gas-liquid two-phase distributor. 25

8. The air-conditioner according to claim 7, wherein at least one of a temperature sensor to measure a temperature of the non-azeotropic refrigerant mixture and a pressure sensor to measure a pressure of the non-azeotropic refrigerant mixture is provided in each of 35

the portion of the first flow path opposite to the side where the first part is connected, with respect to the first gas-liquid two-phase distributor, 40
a portion of the first flow path opposite to the side where the second part is connected, with respect to the first gas distributor,
the portion of the second flow path opposite to the side where the fourth part is connected, with respect to the second gas-liquid two-phase distributor, and 45
a portion of the second flow path opposite to the side where the third part is connected, with respect to the second gas distributor. 50

9. The air-conditioner according to any one of claims 1 to 8, wherein one of a T-shaped branch portion and a Y-shaped branch portion is arranged in a portion where the first flow path and the second flow path are connected in parallel with respect to the refrigeration cycle circuit. 55



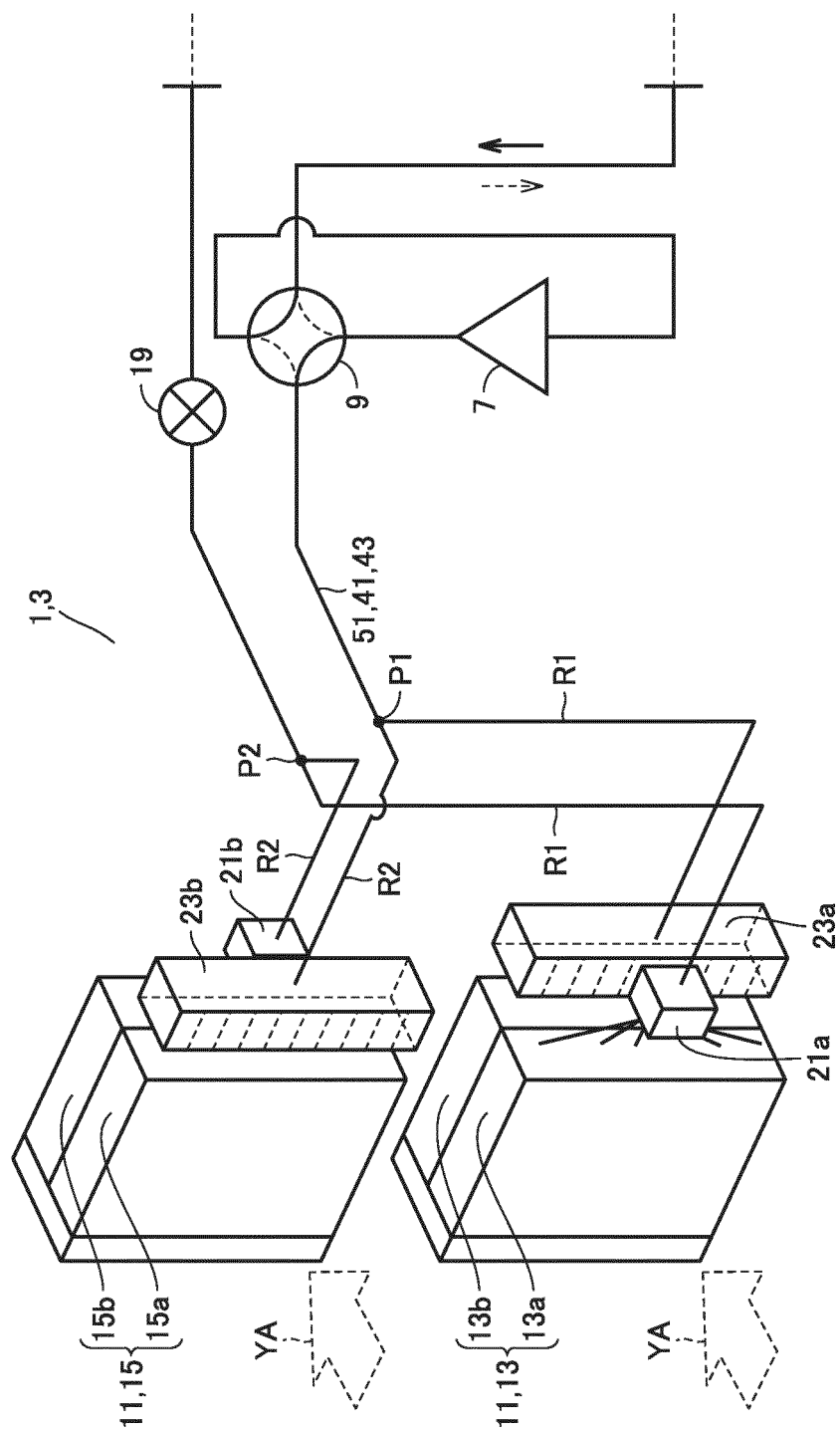


FIG. 2

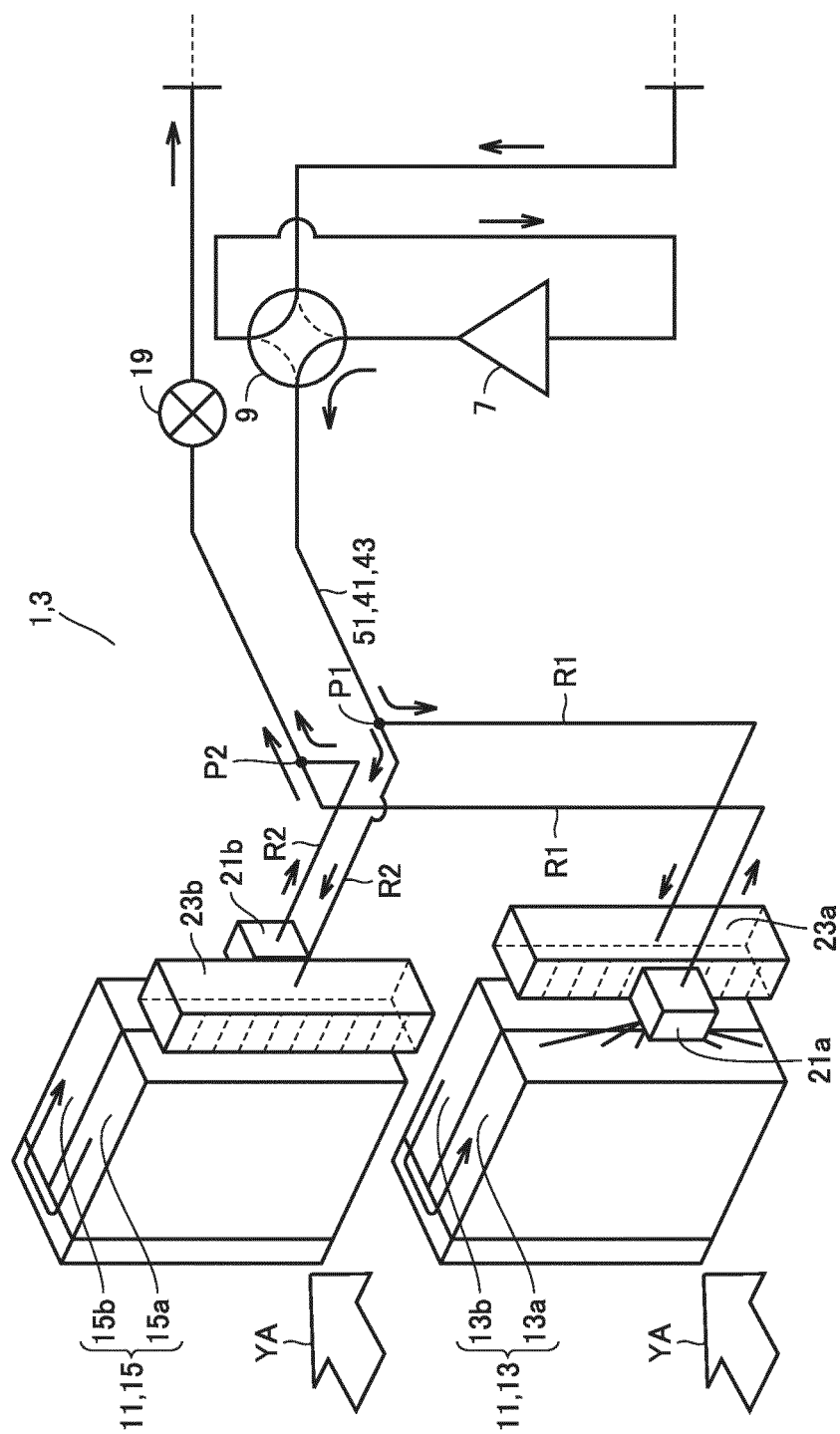


FIG. 3

FIG.4

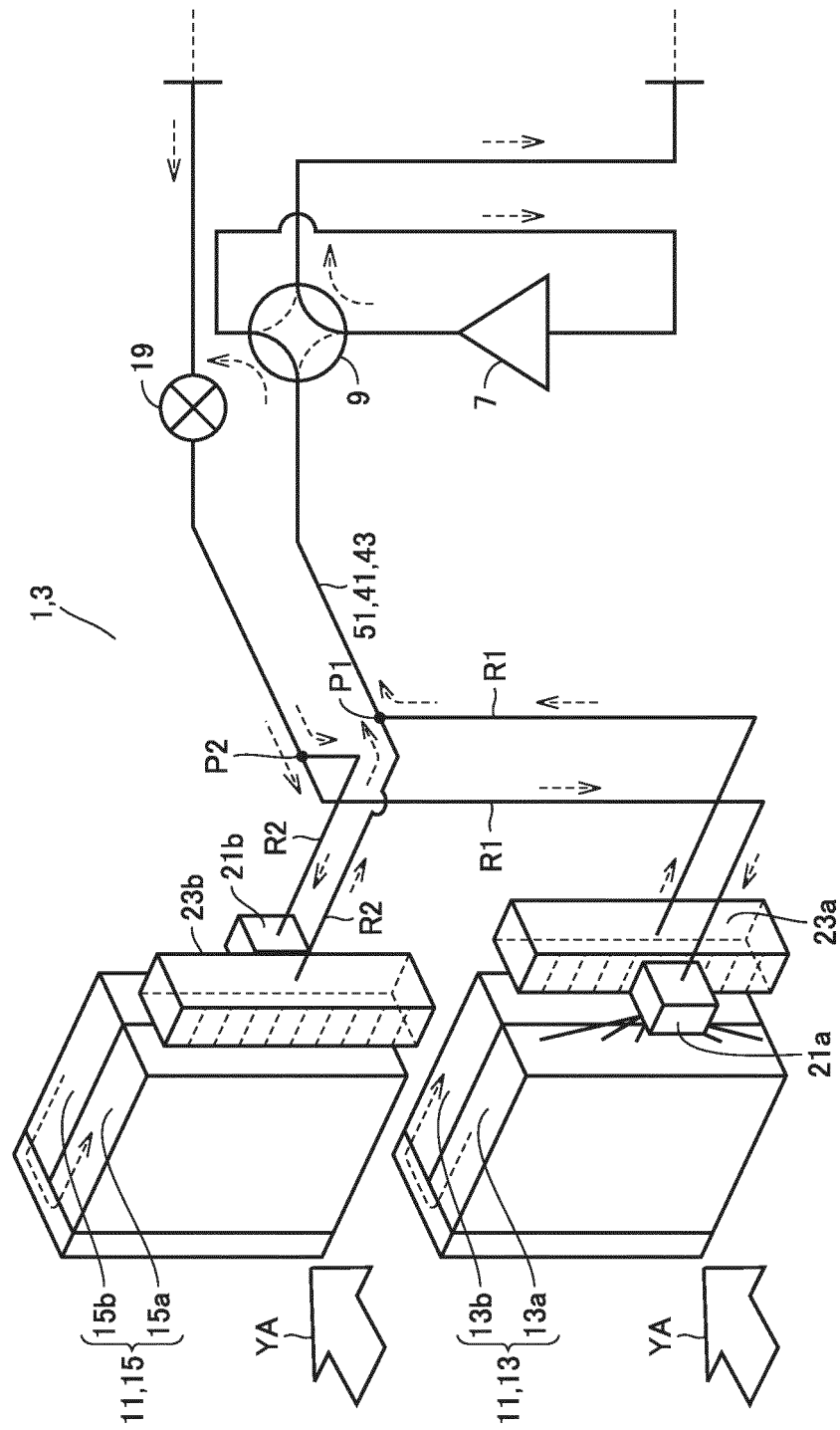


FIG.5

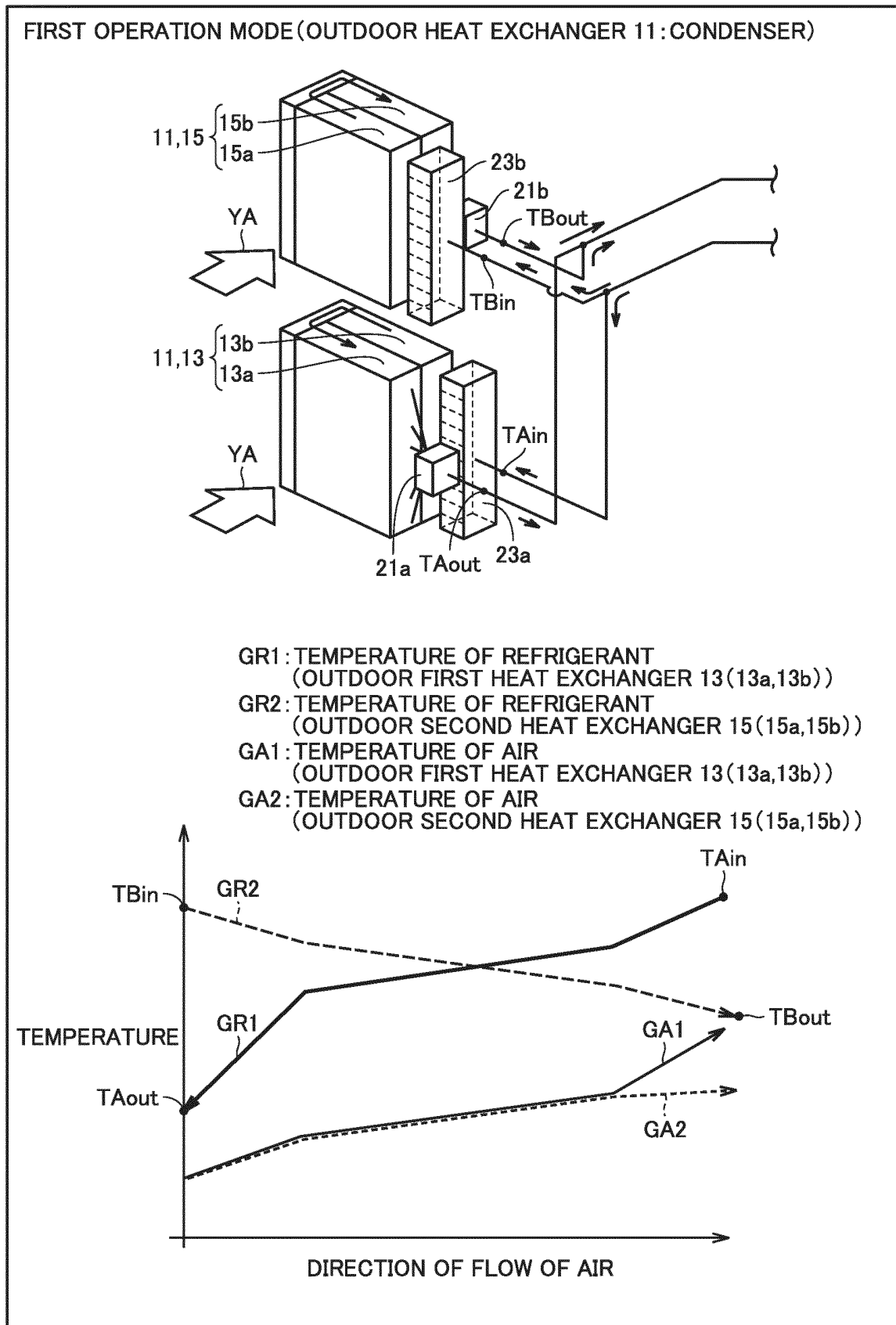
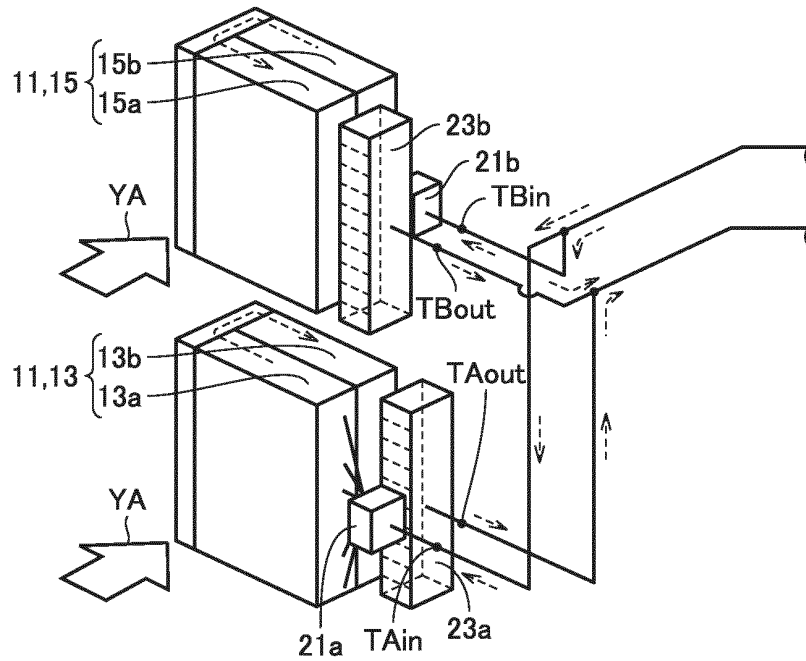


FIG.6

SECOND OPERATION MODE (OUTDOOR HEAT EXCHANGER 11: EVAPORATOR)



GR1: TEMPERATURE OF REFRIGERANT
(OUTDOOR FIRST HEAT EXCHANGER 13(13a,13b))
 GR2: TEMPERATURE OF REFRIGERANT
(OUTDOOR SECOND HEAT EXCHANGER 15(15a,15b))
 GA1: TEMPERATURE OF AIR
(OUTDOOR FIRST HEAT EXCHANGER 13(13a,13b))
 GA2: TEMPERATURE OF AIR
(OUTDOOR SECOND HEAT EXCHANGER 15(15a,15b))

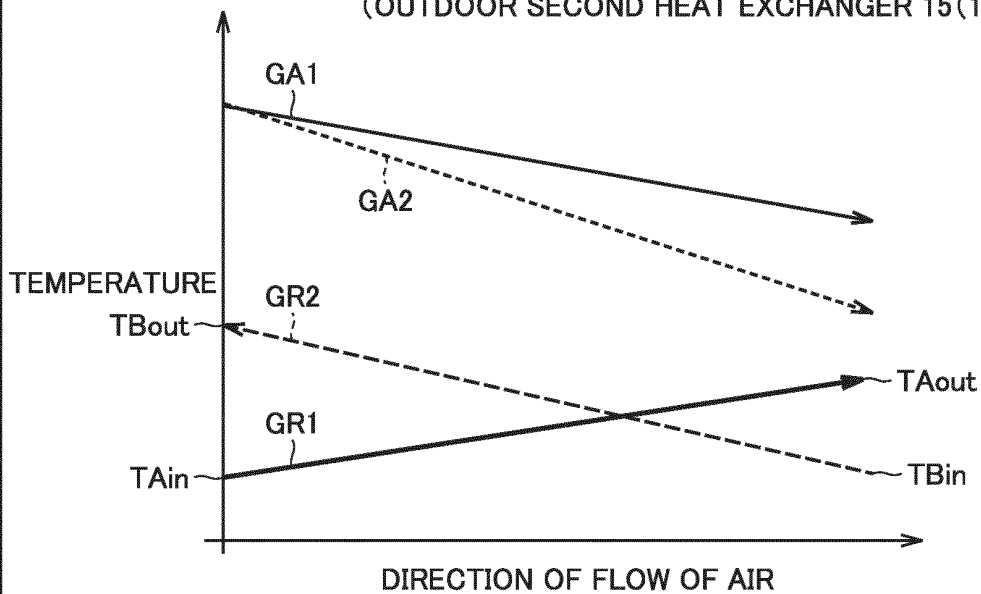


FIG.7

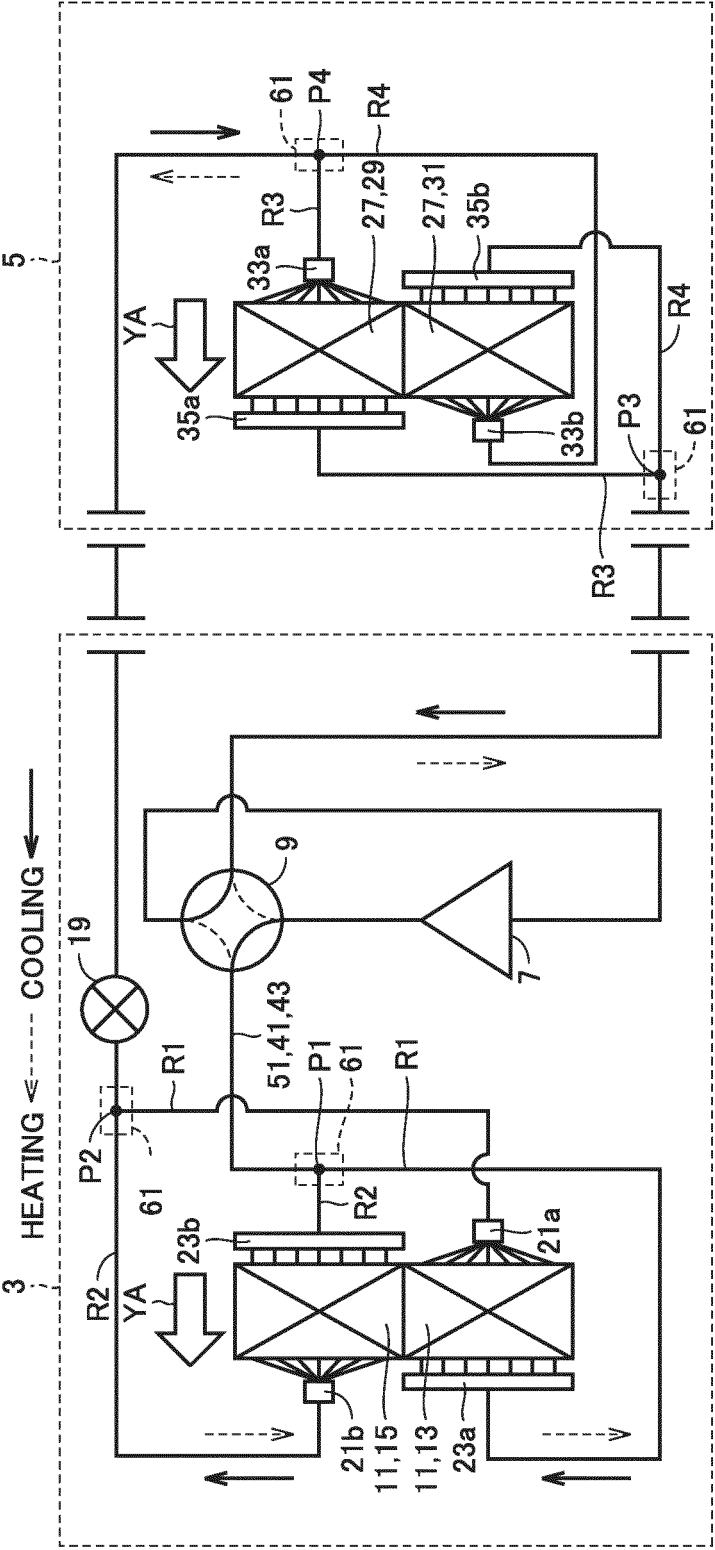


FIG.8

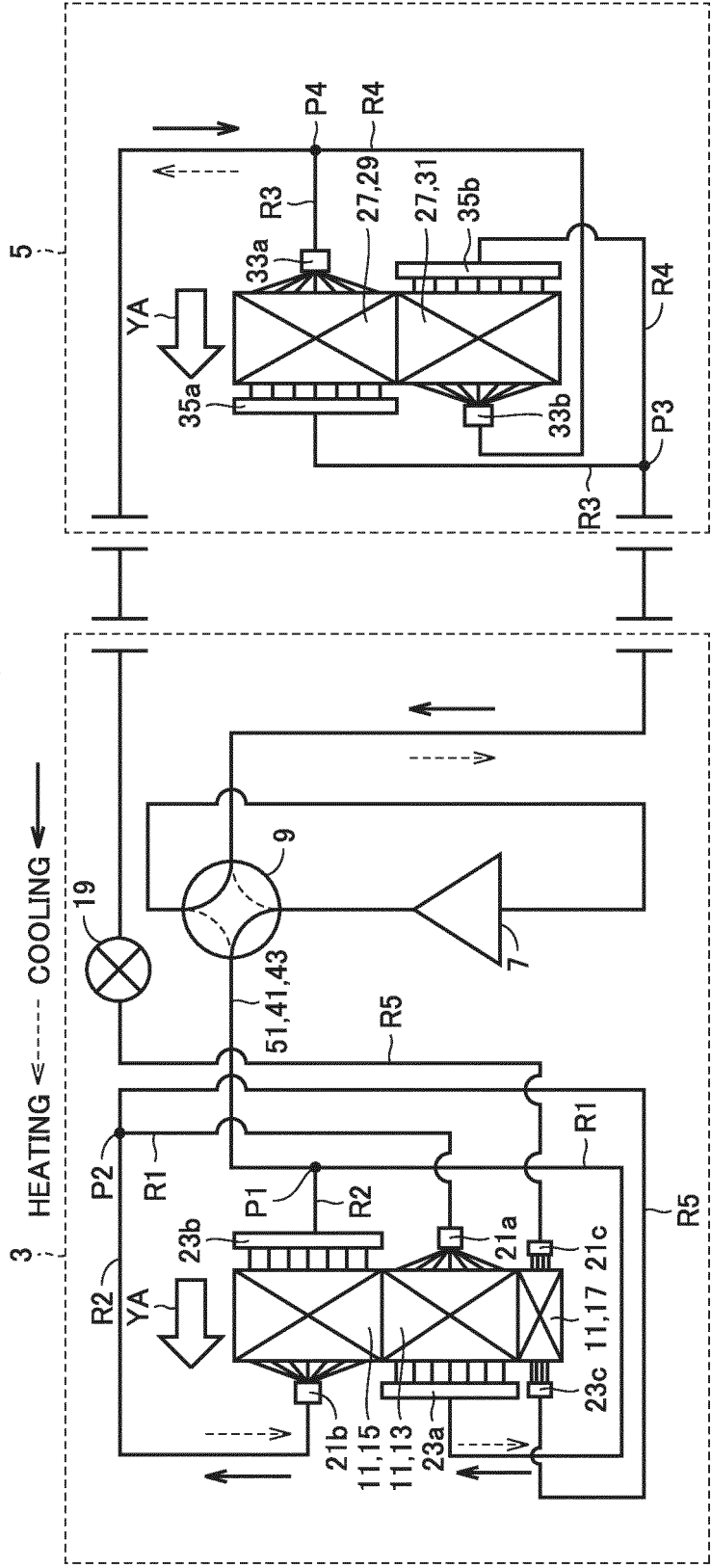


FIG.9

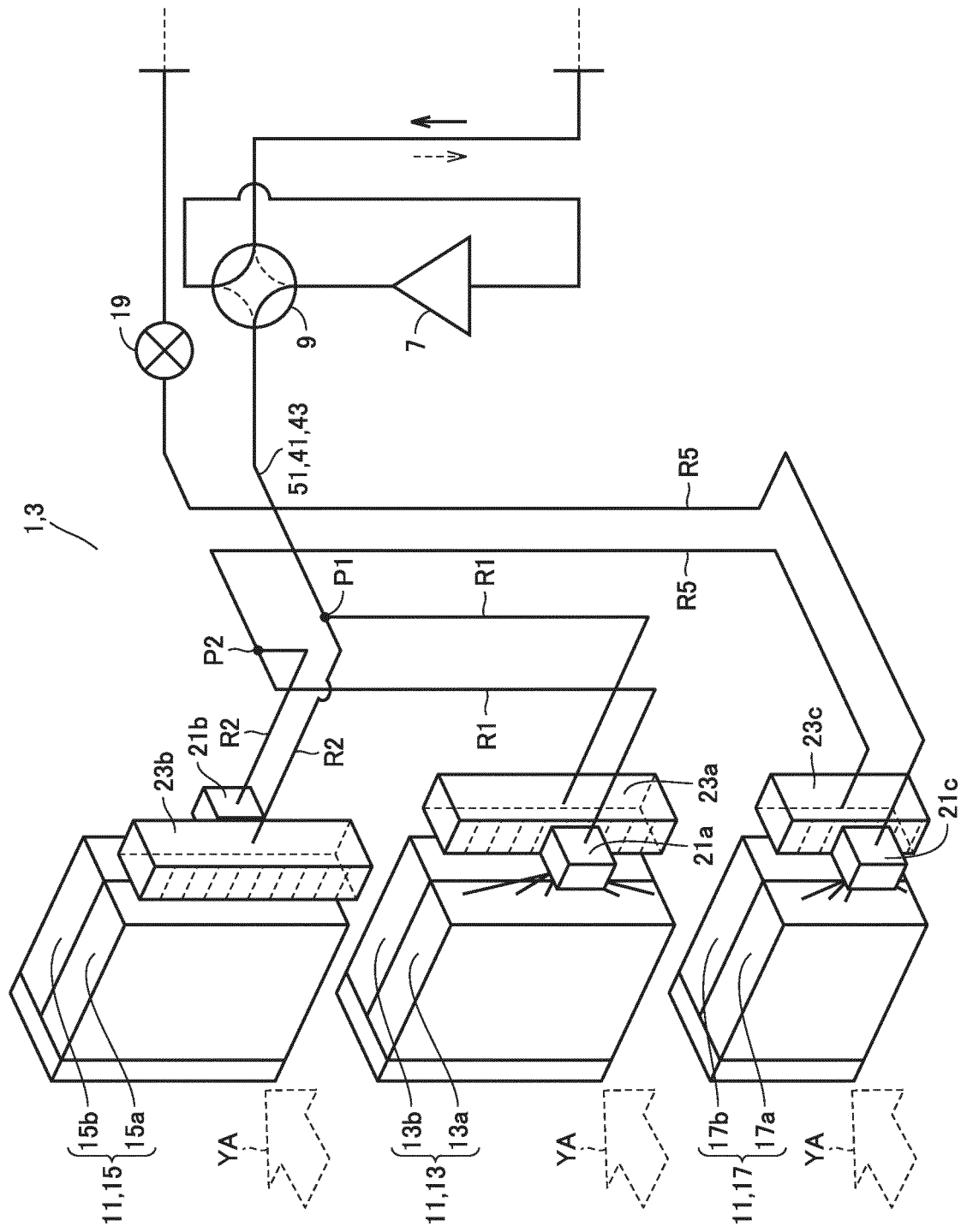
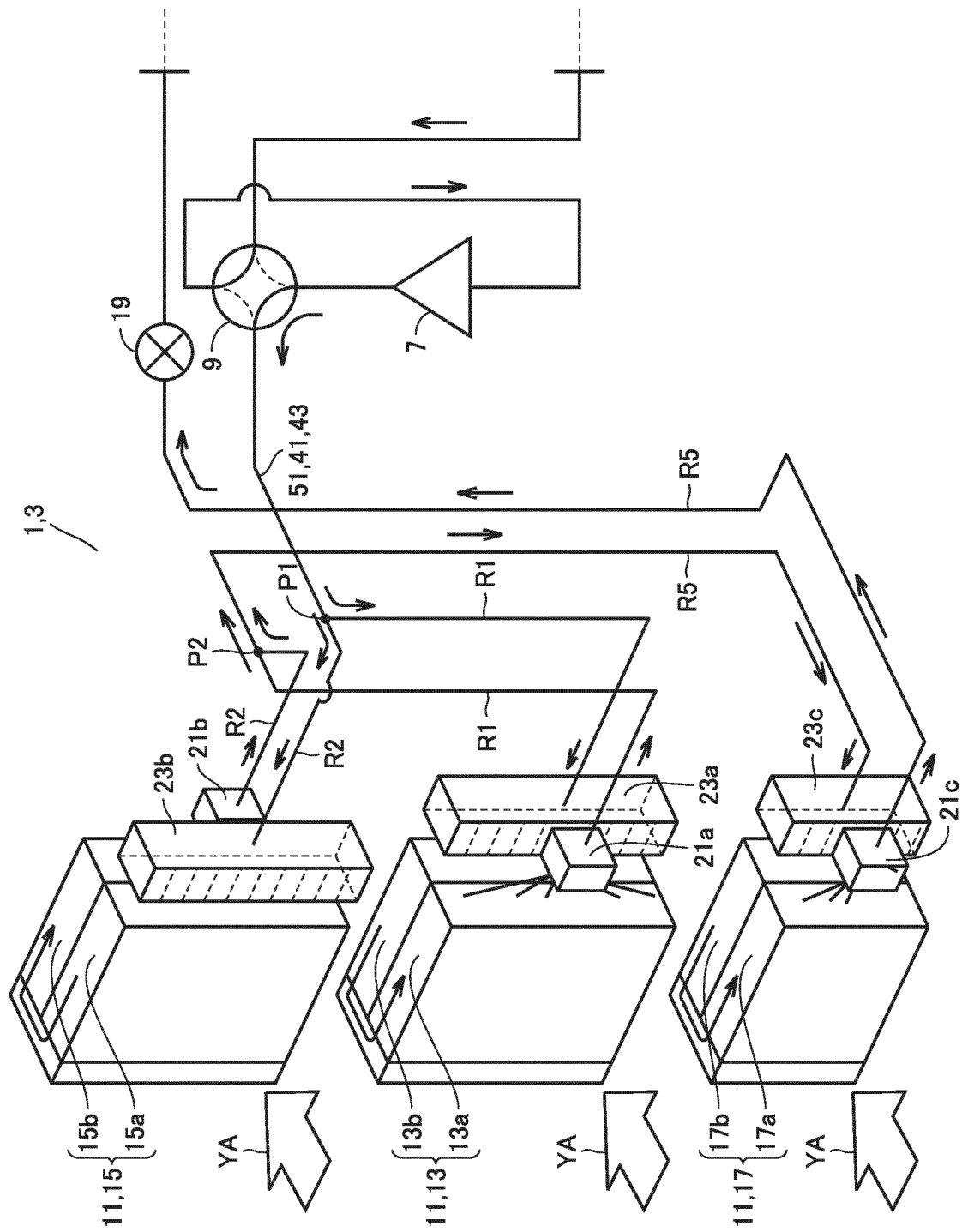


FIG.10



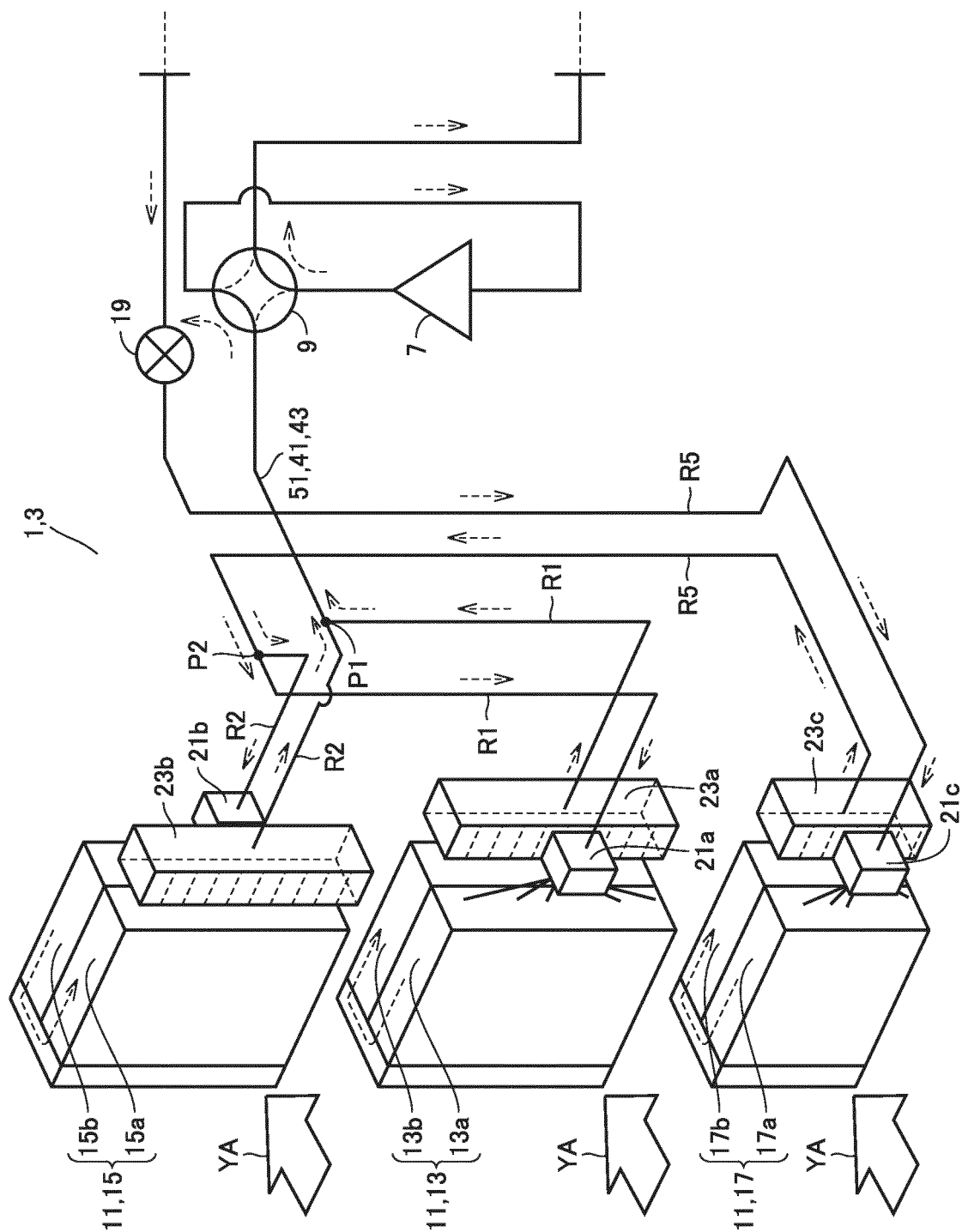


FIG. 11

FIG.12

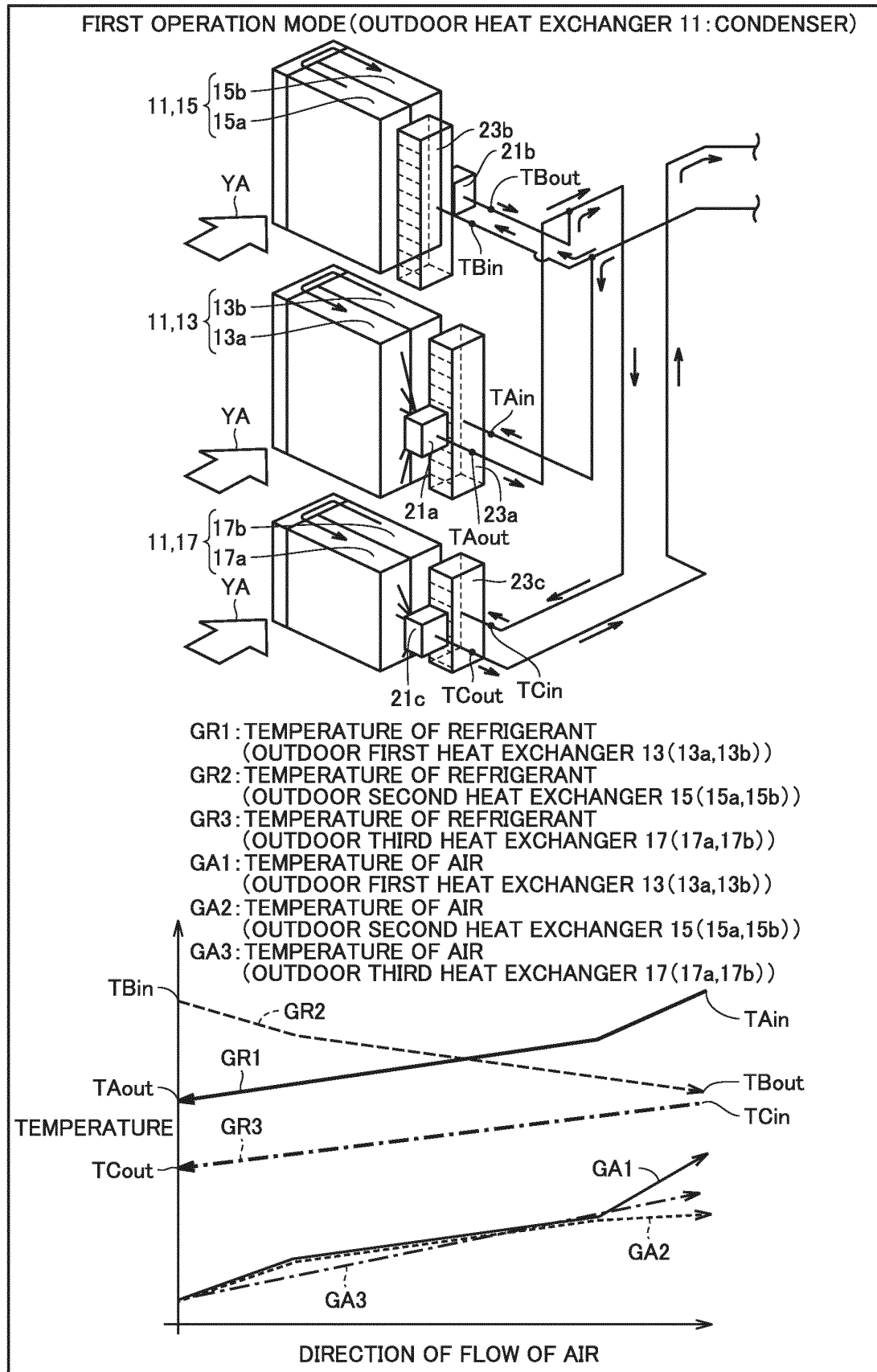
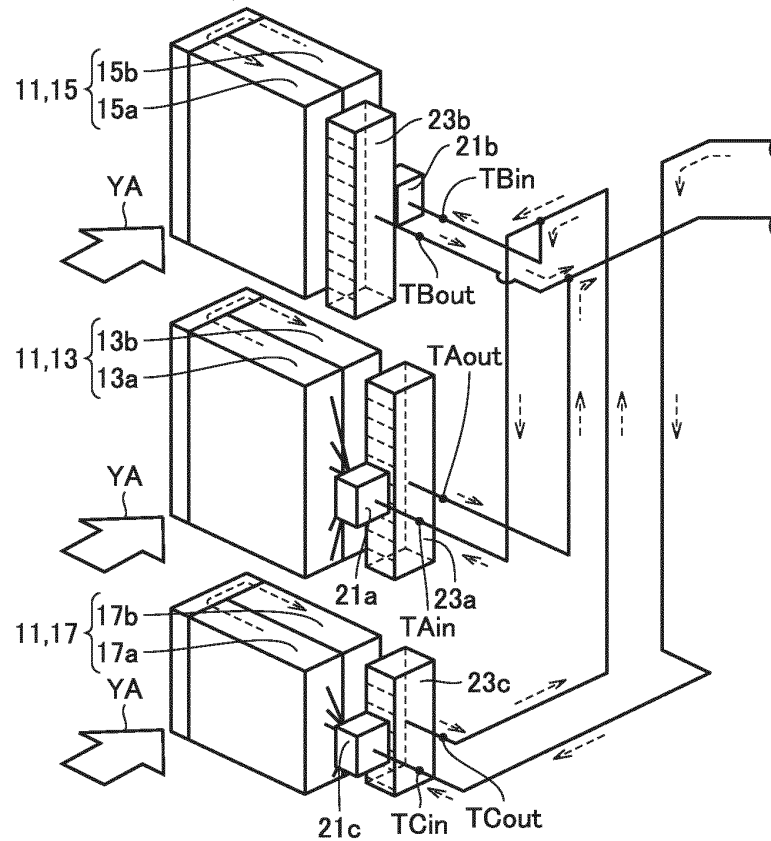
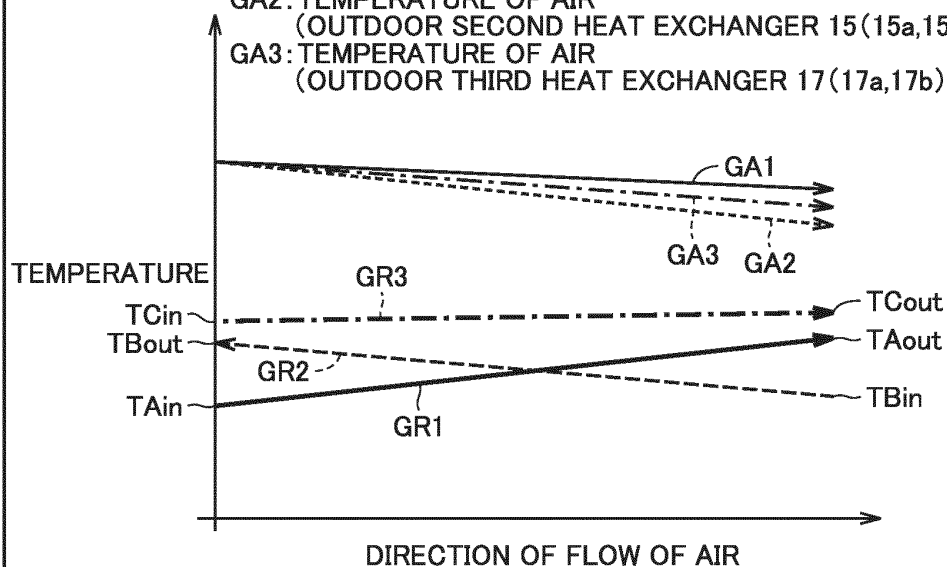


FIG.13

SECOND OPERATION MODE (OUTDOOR HEAT EXCHANGER 11:EVAPORATOR)



GR1: TEMPERATURE OF REFRIGERANT
(OUTDOOR FIRST HEAT EXCHANGER 13(13a,13b))
 GR2: TEMPERATURE OF REFRIGERANT
(OUTDOOR SECOND HEAT EXCHANGER 15(15a,15b))
 GR3: TEMPERATURE OF REFRIGERANT
(OUTDOOR THIRD HEAT EXCHANGER 17(17a,17b))
 GA1: TEMPERATURE OF AIR
(OUTDOOR FIRST HEAT EXCHANGER 13(13a,13b))
 GA2: TEMPERATURE OF AIR
(OUTDOOR SECOND HEAT EXCHANGER 15(15a,15b))
 GA3: TEMPERATURE OF AIR
(OUTDOOR THIRD HEAT EXCHANGER 17(17a,17b))



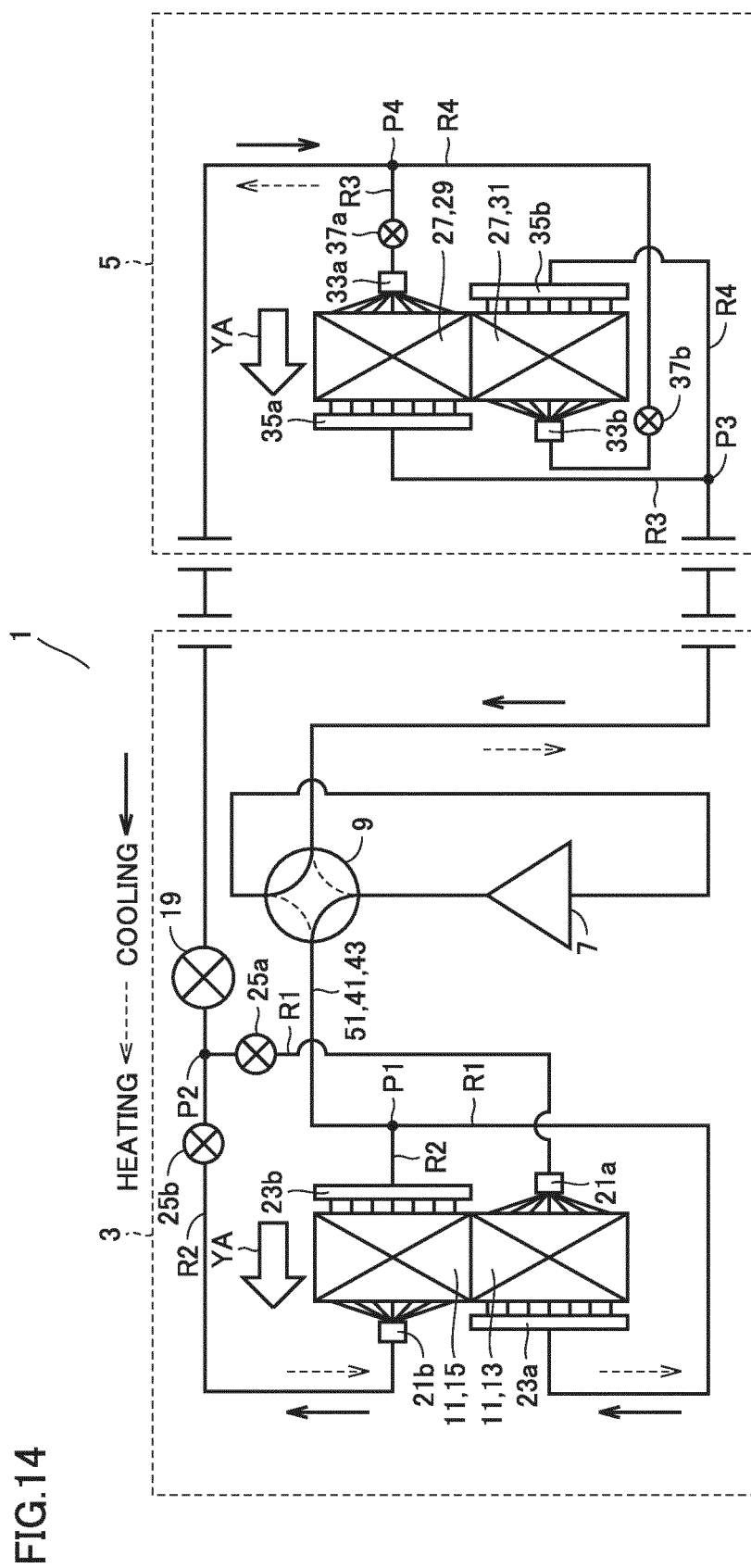


FIG.15

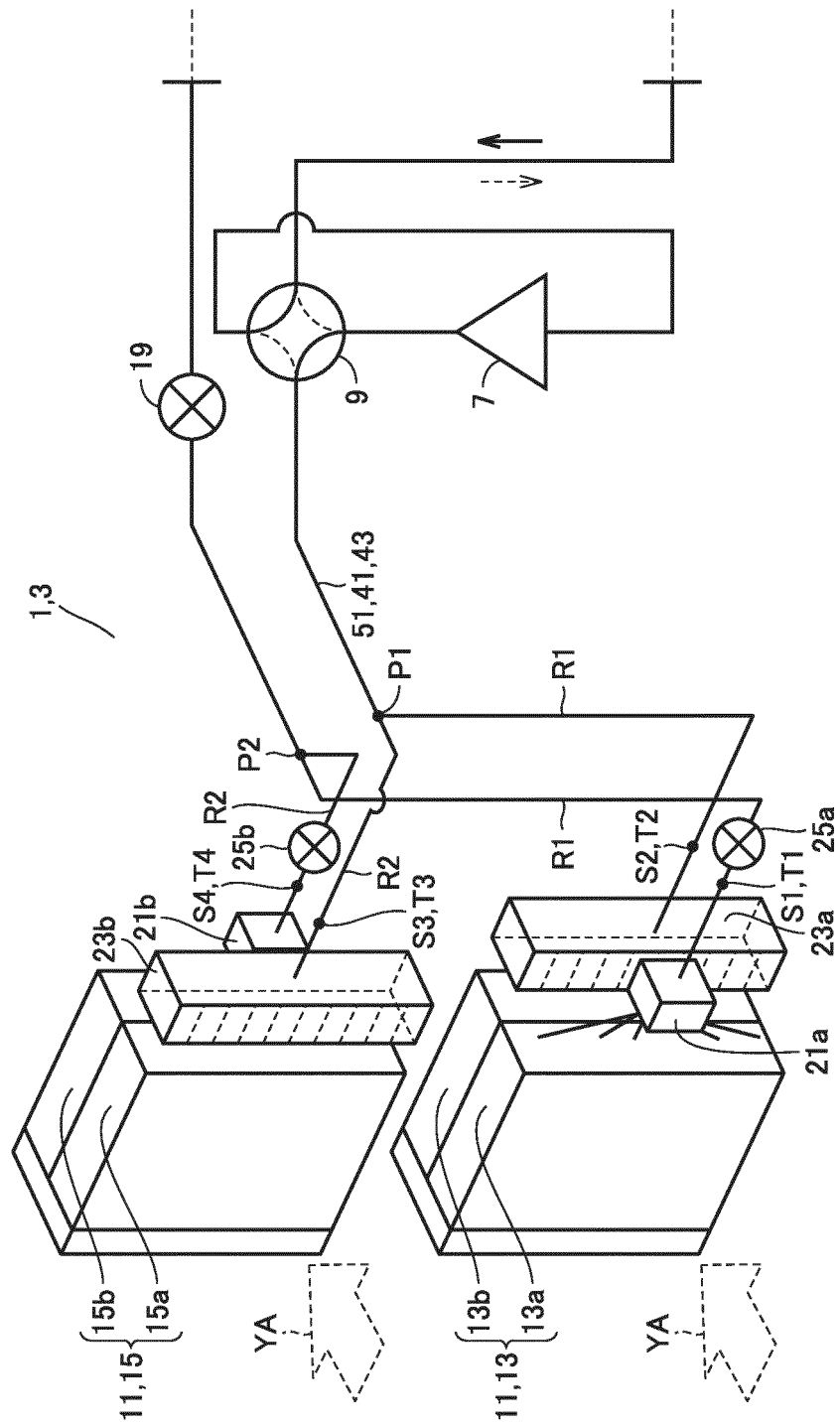


FIG. 16

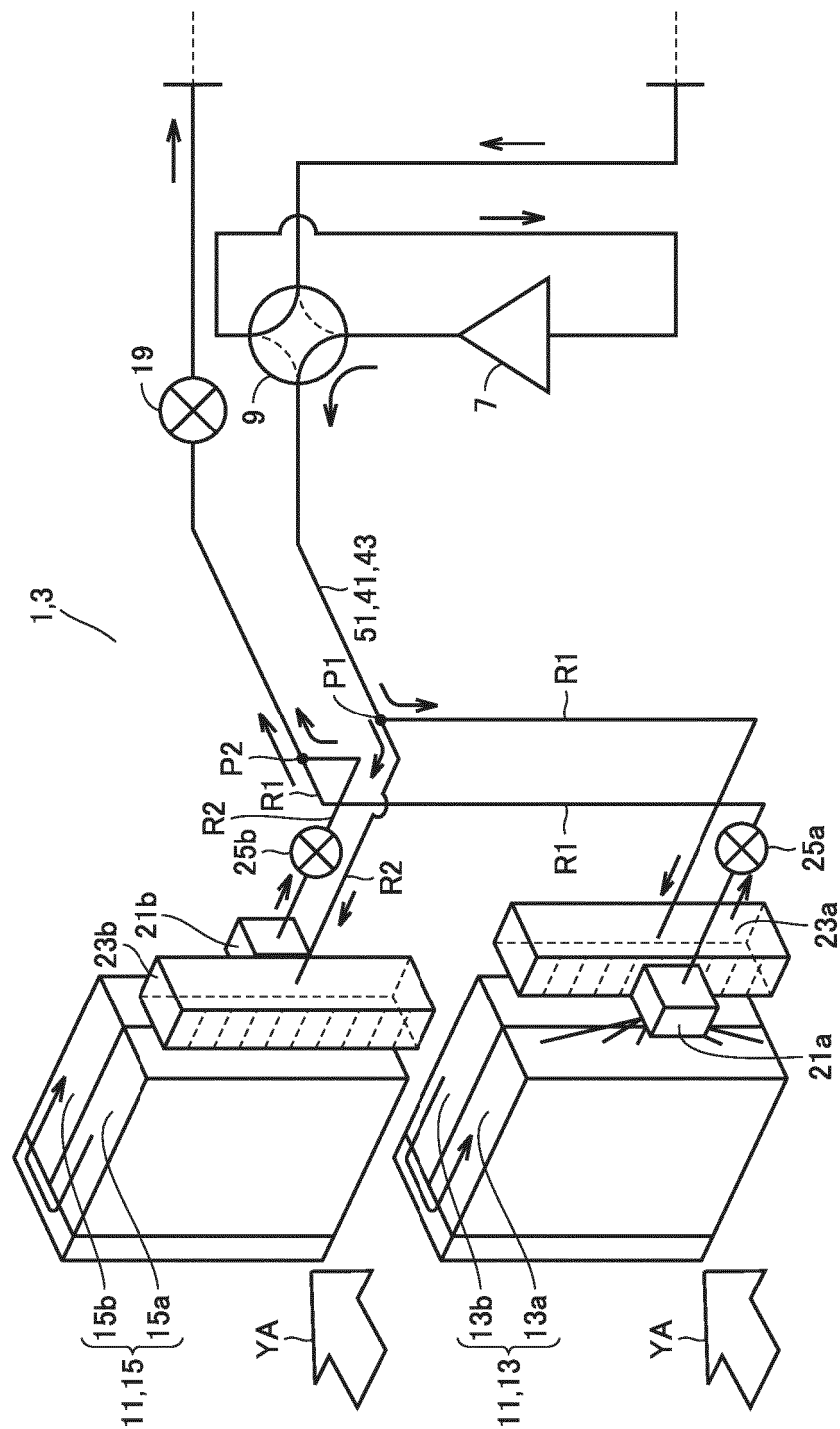


FIG.17

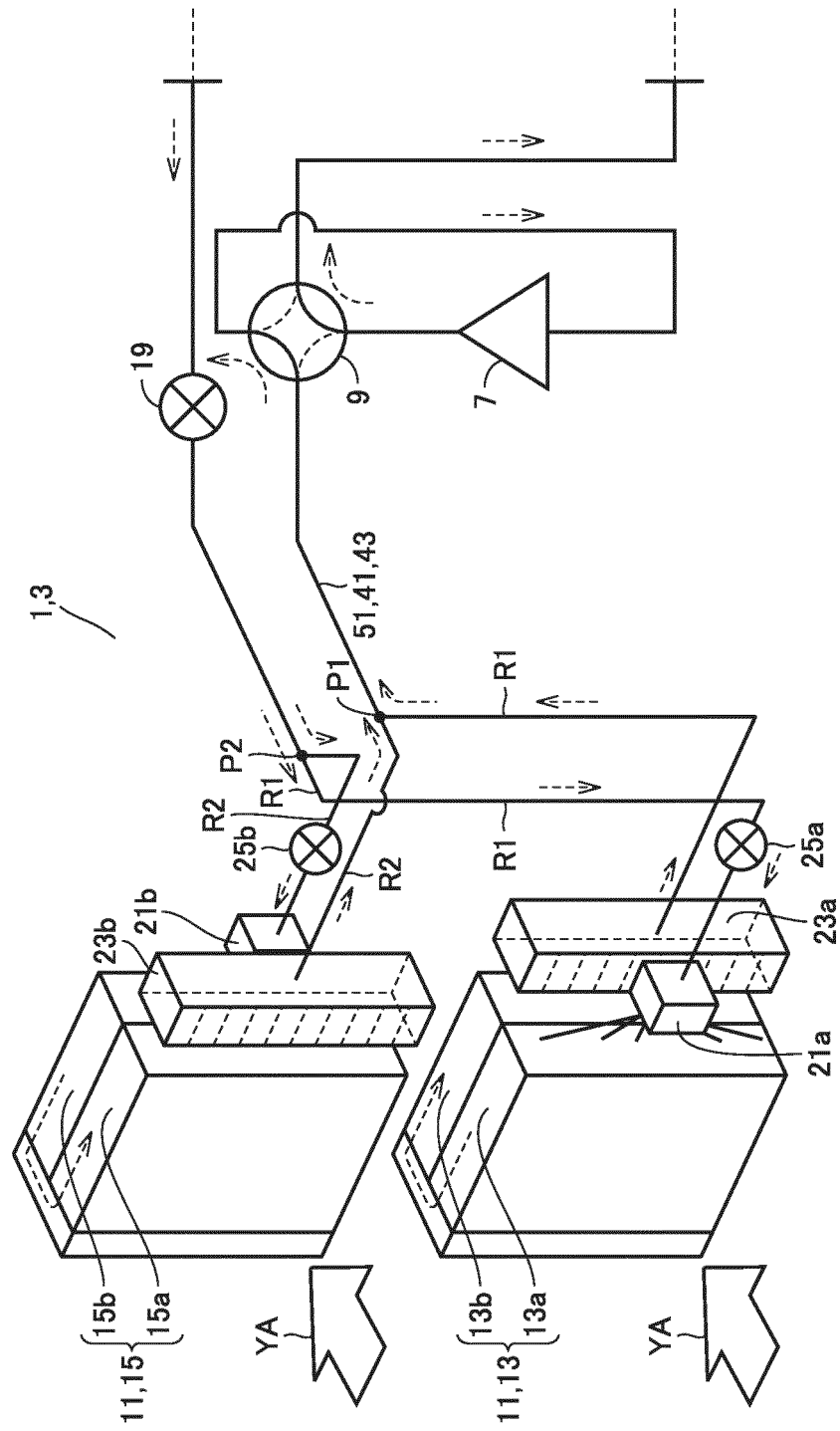


FIG.18

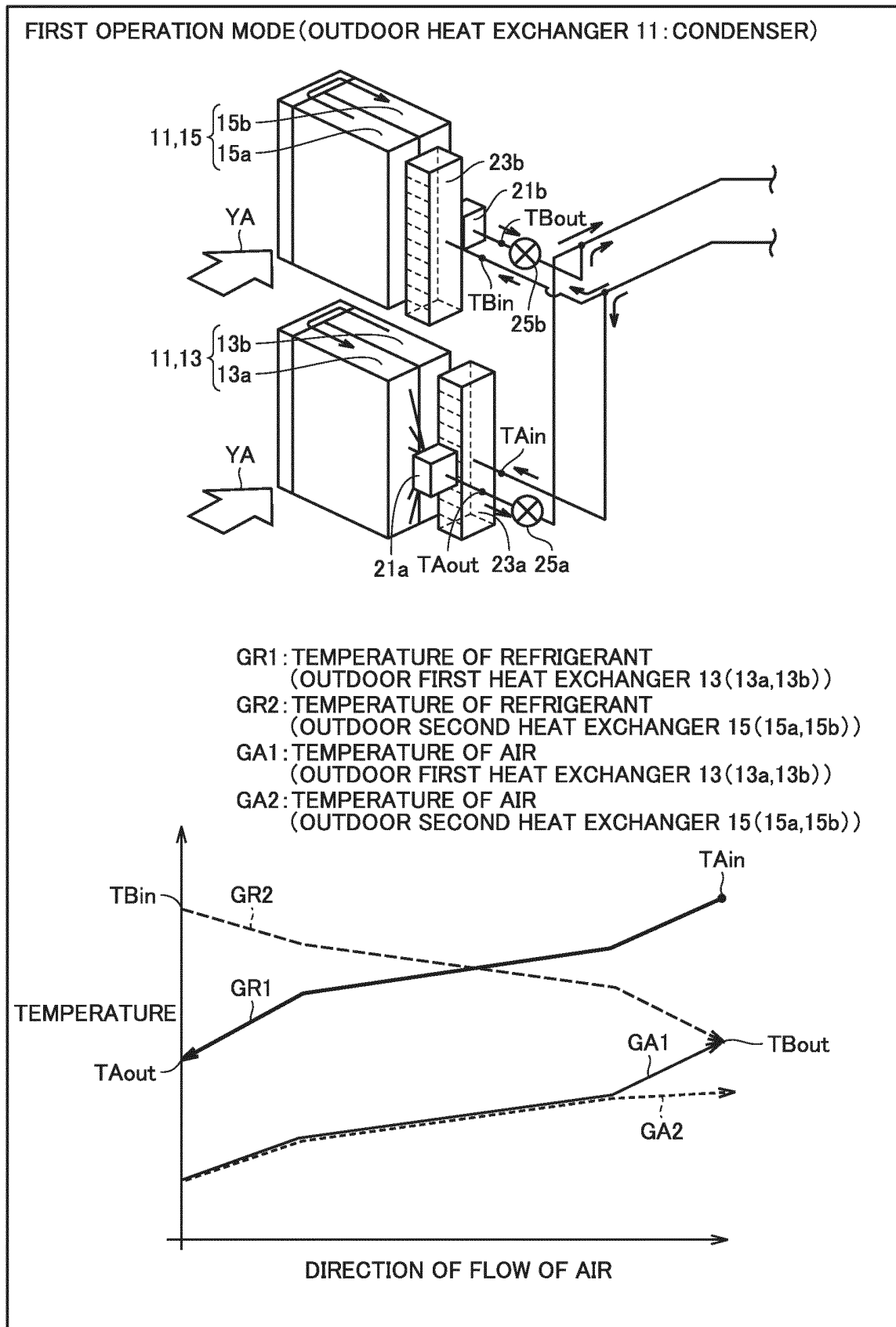
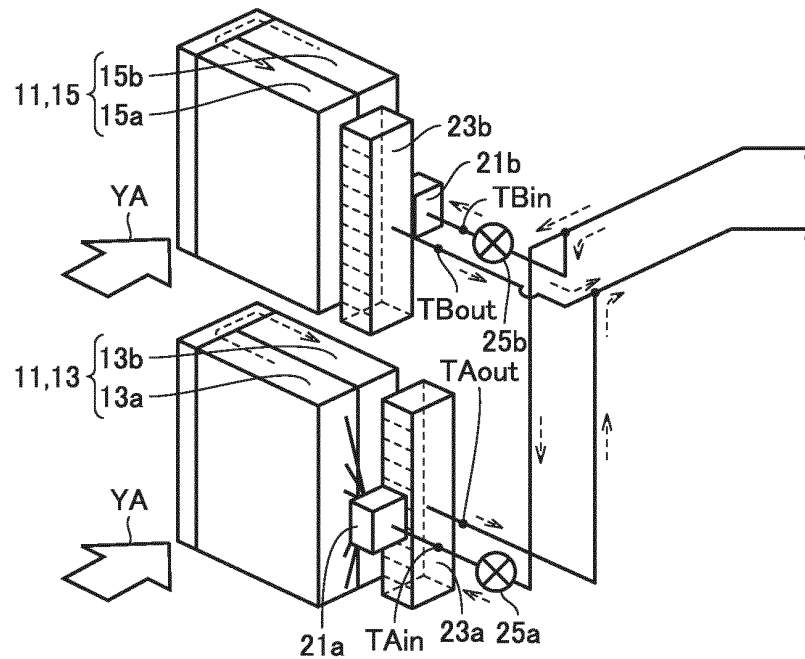
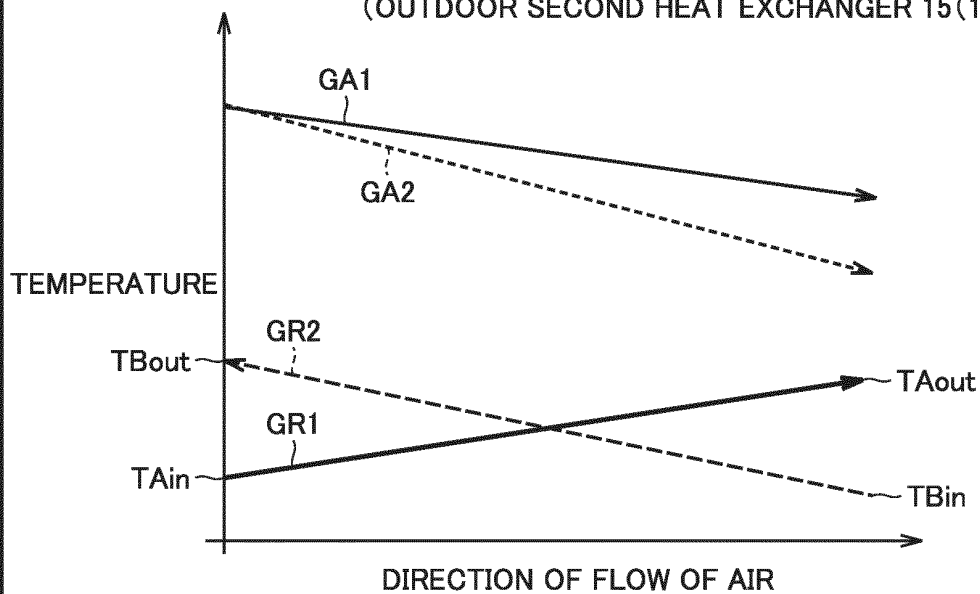


FIG.19

SECOND OPERATION MODE (OUTDOOR HEAT EXCHANGER 11:EVAPORATOR)



GR1: TEMPERATURE OF REFRIGERANT
(OUTDOOR FIRST HEAT EXCHANGER 13(13a,13b))
GR2: TEMPERATURE OF REFRIGERANT
(OUTDOOR SECOND HEAT EXCHANGER 15(15a,15b))
GA1: TEMPERATURE OF AIR
(OUTDOOR FIRST HEAT EXCHANGER 13(13a,13b))
GA2: TEMPERATURE OF AIR
(OUTDOOR SECOND HEAT EXCHANGER 15(15a,15b))



INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2021/016441

A. CLASSIFICATION OF SUBJECT MATTER

F25B 5/02(2006.01)i; F25B 6/02(2006.01)i; F25B 13/00(2006.01)i; F25B 39/00(2006.01)i; F25B 41/42(2021.01)i

FI: F25B39/00 E; F25B41/42; F25B13/00 A; F25B5/02 Z; F25B6/02 Z

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

F25B5/02; F25B6/02; F25B13/00; F25B39/00; F25B41/42

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Published examined utility model applications of Japan 1922-1996

Published unexamined utility model applications of Japan 1971-2021

Registered utility model specifications of Japan 1996-2021

Published registered utility model applications of Japan 1994-2021

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 2018-162964 A (DAIKIN IND LTD) 18 October 2018 (2018-10-18) paragraphs [0050]-[0125], fig. 1-22	1-9
A	JP 2020-153646 A (DAIKIN IND LTD) 24 September 2020 (2020-09-24) entire text, all drawings	1-9
A	WO 2019/003385 A1 (MITSUBISHI ELECTRIC CORP) 03 January 2019 (2019-01-03) entire text, all drawings	1-9
A	WO 2016/001957 A1 (HITACHI APPLIANCES INC) 07 January 2016 (2016-01-07) entire text, all drawings	1-9
A	WO 2018/047416 A1 (MITSUBISHI ELECTRIC CORP) 15 March 2018 (2018-03-15) entire text, all drawings	1-9
A	WO 2018/047331 A1 (MITSUBISHI ELECTRIC CORP) 15 March 2018 (2018-03-15) entire text, all drawings	1-9
A	JP 2010-139097 A (MITSUBISHI ELECTRIC CORP) 24 June 2010 (2010-06-24) entire text, all drawings	1-9



Further documents are listed in the continuation of Box C.



See patent family annex.

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"&" document member of the same patent family

Date of the actual completion of the international search

26 May 2021 (26.05.2021)

Date of mailing of the international search report

08 June 2021 (08.06.2021)

Name and mailing address of the ISA/

Japan Patent Office

3-4-3, Kasumigaseki, Chiyoda-ku,

Tokyo 100-8915, Japan

Authorized officer

Telephone No.

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application no.

PCT/JP2021/016441

Patent Documents referred in the Report	Publication Date	Patent Family	Publication Date
JP 2018-162964 A	18 Oct. 2018	US 2020/0049409 A1 entire text, all drawings WO 2018/180240 A1 EP 3604974 A1 CN 110462309 A	
JP 2020-153646 A	24 Sep. 2020	(Family: none)	
WO 2019/003385 A1	03 Jan. 2019	(Family: none)	
WO 2016/001957 A1	07 Jan. 2016	(Family: none)	
WO 2018/047416 A1	15 Mar. 2018	US 2019/0162454 A1 entire text, all drawings GB 2569898 A WO 2018/047330 A1 US 2019/0383532 A1 entire text, all drawings EP 3511651 A1 CN 109690209 A	
WO 2018/047331 A1	15 Mar. 2018	(Family: none)	
JP 2010-139097 A	24 Jun. 2010		

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP H08170864 A [0004] [0005]
- JP H09196489 A [0004] [0005]